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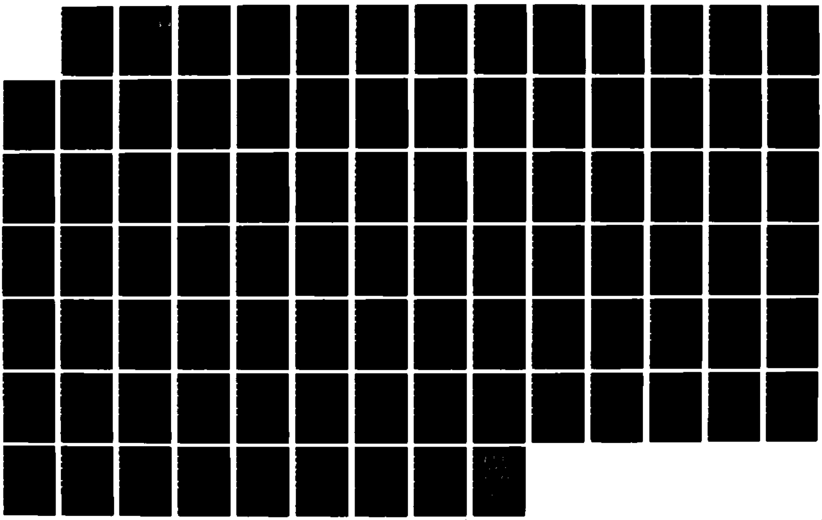

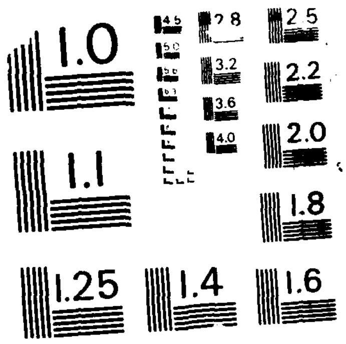

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IMPROVING THE AIR FORCE'S COMPUTATION OF SPARES REQUIREMENTS: THE EFFECTS OF ENGINES

Report AF501R5

December 1986

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The Air Force's computation of replenishment spares requirements ignores the existence of spare engines and the need for them. This overstates the contribution of engine components to aircraft availability rates and distorts the predicted availability resulting from a given investment in spares. This report documents a study of two engines, using the LMI Aircraft Availability Model, which shows that these errors can be significant. The magnitude and direction of the error depends on the balance between requirements for whole engines and the existing spares levels.

In addition to quantifying the effects of engines, this report suggests specific ways in which engines can be included in the availabilty-based techniques now being introduced into the Air Force's computation.

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LMI

Executive Summary

IMPROVING THE AIR FORCE'S COMPUTATION OF SPARES REQUIREMENTS: THE EFFECTS OF ENGINES

The Air Force can improve significantly its estimates of the reparables spares requirement by including the effects of engines and engine modules.

Funding for reparable components is in Budget Program 1500 (BP-15), Aircraft Replenishment Spares. Funding for spare whole engines and engine modules is in Budget Program 1600 (BP-16), Aircraft Initial Spares. The requirements for BP-15 and BP-16 are determined by different organizations.

One consequence of this practice is that the requirements computation for BP-15 ignores engines and engine modules and the need for them. Accounting for engines in that computation could change component requirements substantially.

For example, if engines and modules are accounted for in the spares calculations for three types of aircraft – the C-141, which uses the TF33 engine, and the F-15 and F-16, which use the F100 engine – the associated peacetime spares requirement could be reduced by $24 million. This represents a 20 percent reduction in the safety level requirement for engine components of those airplanes.

But the effects of including engines would not be the same for all engine types and all levels of spares. Component spares requirements can be driven up or down, depending on the balance between engine and module needs and the numbers on hand. Whatever the direction and magnitude of the change, the resultant requirements would be more realistic.

Accordingly, we recommend that the Air Force Logistics Command (AFLC):

- *Incorporate the effects of spare engines and engine modules into its Recoverable Consumption Item Requirements System (D041) computation of the peacetime requirement.* We are not recommending computing *requirements* for engines themselves in D041, merely modifying the computation to recognize their existence and value.

The techniques to do the job already exist. The modifications we developed for the LMI Aircraft Availability Model can readily be incorporated into the D041 system.

In addition, we recommend two related AFLC initiatives:

- *Promote more communication between personnel responsible for the spare engines computation (AFLC/MMMAE, ASD/YZ) and personnel responsible for the components computation (AFLC/MMMR).* The result should be better balance in funding between whole engines and engine components.

- *Give strong management support to the present effort to clean up the Master Materiel Support Record System (D049).* Accurate requirements computations depend on knowledge of which components are installed in a given aircraft and how those components are related to subassemblies. In the search for better data on weapon system applications, the Requirements Data Bank project office is looking to the D049 as a source of application data. This effort merits encouragement.

Adopting these recommendations would result in a more accurate statement of component requirements and provide a basis for balancing the spares levels between engines and their constituent subassemblies.

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and/or
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CHAPTER 1

BACKGROUND

OVERVIEW OF THE PROBLEM

The Air Force Logistics Command (AFLC) is now engaged in modifying its computation of peacetime replenishment spares so that funding requirements can be tied directly to weapon system readiness, as measured by aircraft availability (AA) rates. An AA rate is the percentage of the weapon system inventory that is not expected to be waiting for one or more spare parts. The advantage of an availability-oriented technique is that the requirement for a particular component is based on its contribution to the readiness (as measured by the AA rate) of the weapon system on which it is installed.

Computations of peacetime requirements for reparable spares are determined by the Recoverable Consumption Item Requirements System (D041); these requirements are funded in the Peacetime Operating Stock (POS) portion of Budget Program 1500 (BP-15, Aircraft Replenishment Spares).[1] The D041 data base does not include information concerning either the number of whole engines and engine modules in the inventory or the requirements for them. The reason for this is that engines are funded, not under BP-15, but under Budget Program 1600 (BP-16, Aircraft Initial Spares). Therefore, any availability technique that relies on the D041 data base ignores the buffering effects that spare engines have on the need for engine components and, consequently, cannot measure correctly the contribution of BP-15 engine components to weapon system readiness. This shortcoming undercuts the advantage that availability methods offer over traditional item-oriented measures of supply performance.

This study was undertaken to both quantify the effects of spare engines on the BP-15 requirement and study the feasibility of adding the effects of engines and

[1] BP-15 funding is divided into POS and War Reserve Materiel (WRM) allocations, where the WRM portion is meant to provide for the spares needed in the event of a conflict. This report addresses only the POS portion of the spares requirement; unless otherwise stated, BP-15, in this report, refers to only the POS portion of this budget program.

engine modules to the availability-based techniques now being incorporated into the D041. We emphasize that the D041 lacks the data for measuring *both* the existing *spares levels* for whole engines and modules and the *demands* for *them*.

For a fixed availability target, the inclusion of spare engines reduces the need for engine components, while the inclusion of engine demands (requirements) can increase the need for engine components. Thus, incorporating engines and engine modules into the D041 computation can cause the overall component requirement (that is, the BP-15 funded requirement) to change in either direction.

We have measured these effects with the LMI Aircraft Availability Model (AAM). The AAM has been used for a number of years by the Headquarters, United States Air Force (USAF/LEX), in evaluating budget requirements for BP-15. The AAM is similar in technique to the availability methods being incorporated into the D041. In particular, it uses the D041 data base as input. The AAM is therefore an appropriate analytic tool for testing the feasibility of incorporating engine spares into the BP-15 computation.

Because the AAM depends on the D041 data base, which does not include data on whole engines and engine modules, it treats engine components as though they were directly installed on the aircraft. This treatment, referred to as the "engines transparent" assumption, *overstates* the impact that a shortage of engine components has on aircraft readiness.

Working with the AAM, we have quantified the effects that spare engines have on the BP-15 requirement by calculating, for three chosen weapon systems, the requirement with and without the inclusion of engines. The difference can be measured at macro and micro levels of detail. By the "macro BP-15 requirement," we mean the aggregate bottom-line funding level needed to meet a target availability rate for each weapon system. Requirements at the macro level are used in the formulation of budgets and Program Objective Memoranda (POMs). Of course, the actual BP-15 funding translates eventually into a list of specific component buys; we refer to this itemized list as the "micro BP-15 requirement."

We have found that inclusion of engines (both engine assets and requirements) can lead to significant changes with respect to the macro requirement and the mix of spares that constitute the micro requirement. In the course of making this determination, we have developed the specific techniques required for incorporating

engine assets in the AAM. We believe these techniques can be readily adapted into the D041.

Our finding that the proper treatment of engine assets makes a difference, together with our specific methods for measuring the difference, lead directly to our recommendation that the D041 computation of the BP-15 requirement be modified to reflect the effects of spare engines and modules.

We emphasize that we are not advocating that requirements for whole engines be included in the BP-15 requirements computation, only that the need for engines and engine modules, together with the value of spare engines and modules already in the Air Force inventory, be recognized in the computation of requirements for engine components.

To explain the role of engines more fully, we first describe the underlying maintenance/supply process that any BP-15 computation algorithm is intended to model.

THE MAINTENANCE/SUPPLY PROCESS FOR AIR FORCE REPARABLES

Figure 1-1 depicts a portion of the parts hierarchy, as extracted from the application records of the D041 data base, for the F-16A aircraft. In the context of Figure 1-1, we describe the physical process that governs the requirement for spare parts.

If a failure occurs on an aircraft, the failed component is removed and replaced with a serviceable spare from base supply as soon as one is available. Because this action takes place on the flight line, these components (such as the computer, altimeter, and the F100 engine itself in Figure 1-1) are called Line Replaceable Units (LRUs). LRUs are said to be *first* indenture items with respect to the aircraft.[2]

[2]The term "indenture" is derived from the common practice of listing the parts breakdown of a given end item in a format such that a particular component's subassemblies are *indented* beneath the parent assembly. "Indenture" and "levels of indenture" have become commonly accepted terms, used generically to represent the depth of relationship of the component to the end item of interest.

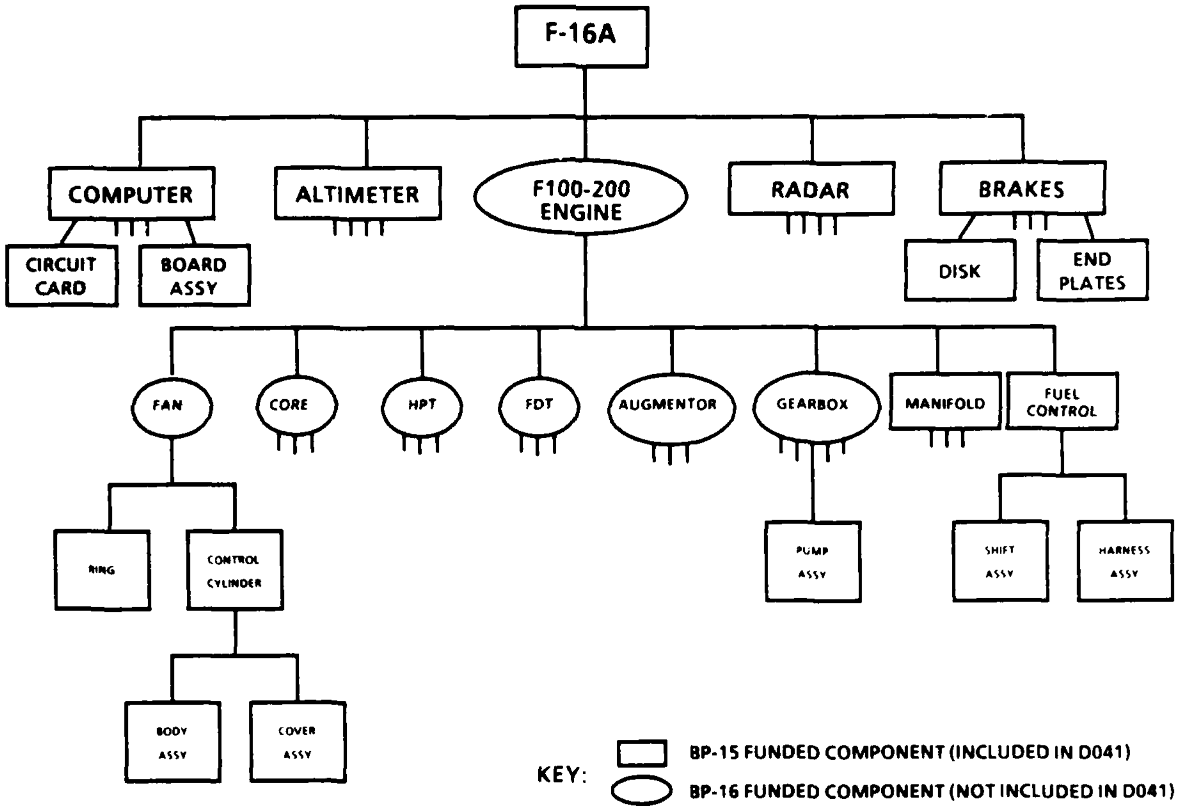


FIG. 1-1. PARTIAL PARTS HIERARCHY FOR THE F-16A

The failed LRU enters base maintenance where it is repaired or, if repair is beyond the base's capability, shipped to the depot for repair. Generally, when the LRU is repaired at base level, the fault is traced to a failed subassembly, or Shop Replaceable Unit (SRU). This *second* indenture SRU is replaced with a spare, and the broken SRU is repaired (possibly by removal and replacement of a faulty *third* indenture item).

The "level of indenture" terminology can be confusing because the definition is stated with respect to the specific end item of concern. This end item is usually – but not necessarily – the aircraft. For example, the computer, altimeter, and F100 engine of Figure 1-1 are all first level of indenture with respect to the aircraft – i.e., they are aircraft LRUs. The circuit card and board assembly are second level aircraft SRUs (belonging to the first level computer), as are the six modules (belonging to the engine parent). On the other hand, the modules can also be thought of as *first* level with respect to the engine itself.

WHY INDENTURE IS IMPORTANT

The AAM computation ignores engines and engine modules in the levels-of-indenture portrayal. Both the demands for engines and modules and the spares levels for engines and modules are "transparent" to the computation. By this we mean that first level engine and engine module components are treated as though they were linked directly to the aircraft. Refer again to Figure 1-1: Spare F100 engines and spare gearbox modules provide two levels of buffering, insofar as the requirement for gearbox subassemblies is concerned. To ignore these buffering effects is to distort both the macro and micro BP-15 requirements.

The process of replacing and repairing aircraft components, as previously described, reveals a distinct difference between the effects of LRUs and SRUs on the end item (aircraft) being supported. The AAM treats, for example, every shortage of the manifold as an aircraft "hole." In reality, however, the aircraft will not feel this shortage at all if a spare engine is available for installation. The effect of shortages for engine components is to delay the repair for engines; this, in turn, can affect the status of aircraft, but only indirectly.

We illustrate the buffering effects of spare engines with extreme cases. If there were a superabundance of spare engines and modules, there would be little need for engine components. Although the lack of engine component spares would delay base repair of engines, there would be enough spare engines in the system to fill the expanded pipeline with little effect on aircraft readiness. On the other hand, if there were no spare engines, the engine-transparent treatment would measure correctly the contribution of a particular engine subassembly to aircraft availability. The actual effects lie between these two extremes.

At the micro level, however, the engine-transparent assumption, at a fixed level of investment, has a tendency to overstate the buy quantity for each engine component. But the proper treatment of engines can make the macro BP-15 requirement (for a fixed level of weapon-system readiness) change in either direction. The direction and magnitude of the change is dependent on the balance between the actual spares levels and the demands for engines and modules.

The preceding discussion was meant to describe, in general terms, the role of the hierarchical indenture structure in a weapon system oriented computation of the BP-15 requirement. Although we have made assertions about the effects that spare engines have on the BP-15 requirement, we have been deliberately vague about any computational algorithm.

We have shown that the present emphasis on measures of weapon system readiness measures – aircraft availability rate being one – makes the proper treatment of engines especially relevant. We shall return to this point after a brief history of the spares modeling techniques employed by the Air Force and a description of what the transition to availability methods means with respect to the engine problem.

PRESENT AIR FORCE POLICY REGARDING SPARES

Modeling Techniques

In the past, Air Force modeling of the reparable spares requirement has been based on traditional measures of supply performance, such as fill rate and number of backorders.[3] Backorder calculations are based on the Multi-Echelon Technique for Recoverable Item Control (METRIC) model [1]. METRIC determines stockage levels in a two-echelon inventory system, that is, one that has two levels of supply – base and depot. METRIC finds the optimal set of items for procurement that minimize the total expected base backorders, subject to an investment constraint.

The BP-15 computation is now performed with the Variable Safety Level (VSL) model, a part of the D041 system. The VSL model "buys" components according to their value in reducing the weapon system backorders, as calculated with METRIC techniques. The VSL stops buying when an overall fill rate criterion for the weapon system has been met.

A limitation of the original METRIC formulation and its derivative VSL is that they are single-indenture models. An expected backorder on an SRU is considered as important as one on an LRU; i.e., the hierarchy shown in Figure 1-1 is ignored.

[3]"Fill rate" is defined as the percentage of demands that a given supply activity can fill without delay from on-hand stock. "Backorders" are unfilled demands for a given component.

This failing has been of concern to the Air Force for some time. As a result, the METRIC model was extended to include in the backorder calculation the proper treatment of indenture. Interestingly, the extended model, MOD-METRIC [2], was originally developed and is still used for determining the proper mix of whole engine and engine module spares for the F100 engine. MOD-METRIC is usually executed with a target ready rate[4] for the engine, that rate implicitly defining the cost constraint. Thus, MOD-METRIC, though it treats indenture properly, projects these engine requirements without explicit regard to considerations of *aircraft* readiness. Moreover, the MOD-METRIC techniques for handling the indenture relationships have not as yet been incorporated into any D041 computation.

The Aircraft Availability Model (AAM)

We have extended the backorder computation techniques of METRIC and MOD-METRIC to a model, the LMI AAM, which relates BP-15 funding to aircraft availability (AA) rates. As noted earlier, the AA rate, for a particular weapon system, is defined as the percentage of aircraft that are not waiting for a BP-15 component.[5] The AAM constructs, for each weapon system, an entire curve that relates BP-15 funding to aircraft availabilities. Each point on the curve is optimal in that it represents the maximum availability possible for that level of funding or the minimum funding required to achieve that availability rate.

The AAM uses the D041 data base and has borrowed heavily from VSL computational techniques. In particular, the pipeline calculations are identical.[6] It is Air Force policy that the buy requirement for an individual component should, at a

[4]The "ready rate," which is closely related to fill rate, is discussed in Chapter 3.

[5]AA rates are related to the Not-Mission-Capable-Supply (NMCS) measures reported daily at each base.

[6]The term "pipeline" refers to the expected number in some form of resupply. For example, the Base Repair Pipeline refers to the amount of assets expected to be undergoing base repair at some moment.

minimum, bring the asset position up to the total pipeline value. (This is referred to as "filling the pipeline.") The requirement for a given item can then be expressed as:

$$\text{REQUIREMENT} = \text{PIPELINE} + \text{SAFETY LEVEL},$$

where SAFETY LEVEL represents the amount of additional stock procured to guard against uncertainty in either the demand or resupply process. The AAM and VSL differ only in terms of the safety level portion of the requirement. The AAM buys safety levels and builds the availability/cost curves by considering the benefit to be gained – as measured by the increase in availability – by each additional spare.

The AAM has been used since 1976 by the Air Staff in the justification of POMs and budgets, and in assessing the weapon system implications of a given level of BP-15 funding.

The Transition to Weapon System Orientation of Requirements

Availability techniques have become commonly accepted. Indeed, the Secretary of Defense, in his FY86 – FY90 Defense Guidance, states that:

> Our objective is to size and fund peacetime operating stocks (POS) of spare and repair parts to achieve explicit weapon systems availability goals at planned operating tempos.

In support of this guidance, the Supply Management Policy Group (SMPG) of OSD has issued specific recommendations [3] to all of the Services for incorporation of weapon system-management practices. These include the goal of developing multi-echelon requirements models that optimize stockage levels to achieve "weapon system operational availability rates."

The Air Force plans to implement the DoD-approved weapon system management concept in conjunction with development of the Requirements Data Bank (RDB), a comprehensive data base and requirements determination system that is to be used ultimately for the management of all reparable, consumable, and equipment items.

Both the SMPG and the RDB project office have recognized that a key element in weapon system management of spares is the existence of accurate weapon system application files, including the data necessary for establishing the appropriate

linkage between components to their next higher assemblies, and ultimately to the weapon system.

In addition, a stated goal of both the SMPG and the RDB project is integrated computation of the BP-15 and BP-16 requirements. Incorporation of engine assets into the BP-15 computation is an important step toward that goal.

PROJECT OBJECTIVES AND ANALYTICAL TECHNIQUES

The move to weapon-system-based computations of spare parts requirements provides the perspective from which the proper treatment of engines becomes important. Put another way, if the present VSL methodology were to continue, there would be no need to incorporate engine effects, because the VSL, by its very design, does not distinguish LRUs from SRUs. Since AFLC is already moving toward incorporation of availability methods into the D041, however, it is appropriate to consider the feasibility of incorporating the effects of spare engines into the D041 computation and, ultimately, into the RDB system.

The main purpose of this study is to develop a prototype version of the LMI AAM that incorporates the effect of spare engines and engine modules, and, based on the results of the prototype, to make recommendations as to the value and feasibility of implementation into D041.

These points are included in our study agenda:

1. Identify sources of data concerning failure rates, resupply times, etc., for engines and modules.

2. Produce a methodology for projecting peacetime asset levels for engines that is compatible with AFLC policy for determining engine requirements.

3. Observe engine management practices at bases and depots to make sure that our modeling assumptions are compatible with Air Force experience.

4. Modify the AAM to include the proper treatment of engine assets. Mainly, this means preventing the model from buying engines, because engine requirements themselves are not germane to our objectives.

5. Determine the ease with which the modifications of the AAM can be adapted into the D041 computational process.

Major Issues

There is nothing inherently difficult about including the effects of engines in an AAM computation of the BP-15 requirement, since the AAM is designed to handle the tradeoffs involved in the indenture relationship of components.

Nonetheless, two main issues remain. The first is determining the appropriate *peacetime* asset levels for engines. Engine requirements and current on-hand inventory levels are largely driven by *wartime* requirements. Care must therefore be taken to set the asset levels in a manner that is consistent with AFLC policy for peacetime computations.

A second consideration is accurate portrayal of the indenture structure for engine components. Despite their physical attachment to the engine, some – *notably fuel control parts – can be replaced on the flight line; i.e., without removal* of the engine. These components should be treated in our model as aircraft LRUs that are linked directly to the aircraft. The identity of these items (which we refer to as engine accessories or "de facto LRUs") is not readily apparent from the D041.

Strategy for Analysis

Our implementation strategy for the prototype model consists of:

1. Selecting engine types and weapon systems for analysis.
2. Building, from the D041, a sample data base that corresponds to the weapon systems chosen.
3. Collecting the data for engines and modules required by the AAM. These data include the failure rates and resupply times necessary to compute pipeline values, as well as projected asset data.
4. Designing a method for computing *peacetime* asset levels for engines and engine modules.
5. Modifying the levels-of-indenture preprocessing software to handle various strategies for defining the "de facto LRUs."
6. Modifying the AAM code so that spare engines will be considered static assets whose subassemblies are properly portrayed in the indenture structure. The modified AAM must be prevented from "buying" whole engines and modules.

7. Comparing the safety levels resulting from two executions of the AAM: one with the standard treatment (engines transparent) and a second with engine assets and indenture structure included.

8. Performing sensitivity analyses, particularly with respect to the appropriate engine asset position and portrayal of engine indenture (Points 4 and 5 above).

9. Drawing conclusions on the basis of this study, concerning the value of including engine assets in the D041 computation of the BP-15 requirement.

The results of our analysis are summarized in Chapter 2, the details of our method in Chapter 3, with special emphasis on techniques that could be readily incorporated into a revised D041 computation. Chapter 4 summarizes the reasons behind our main recommendation, incorporating the effects of engines into the D041, and includes specific suggestions toward carrying out this recommendation.

CHAPTER 2

QUANTIFYING THE EFFECTS OF SPARE ENGINES

Our overall strategy calls for analyzing the effects of spare engines on the BP-15 requirement by comparing the safety-level buys of two executions of the LMI AAM: one under the "engines transparent" assumption, the other with the proper "engines included" treatment. This approach requires the extraction from the D041 of the data corresponding to those components on the weapon systems chosen for analysis. In addition, to produce the "engines included" AAM output, comparable D041 data (principally the pipeline quantities and resupply times) for engines and modules must be collected and added to our sample data base.

In addition to reporting the results of our comparisons of the two AAM executions, this chapter tells how the data base was created, including the documentation of sources for the required engine data. We also describe the solutions to the two major problems: (1) determination of peacetime asset levels for engines and modules and (2) identification of engine components that are in fact directly removable from the aircraft on the flight line (the "de facto LRUs"). Our techniques are not just the means to an end (quantifying the effect of spare engines on the BP-15 requirement); they represent *results* in their own right because they represent solutions to the problems associated with implementation throughout the Air Force.

BUILDING THE SAMPLE DATA BASE

Selecting Engine Types

We selected for analysis two engines in the Air Force inventory – the TF33-P-7A, which is installed on the C-141 (four per aircraft), and two versions of the F100 engine. The F100-100 is installed on the F-15 (two per aircraft); the F100-200 is installed on the F-16 (one per aircraft). Table 2-1 shows the projected

application data and flying-hour programs for each of these engines in the fourth quarter of FY88.[1]

TABLE 2-1

ENGINES AND WEAPON SYSTEMS IN THIS STUDY

Engine	Weapon system (MDS)	Quantity per application	Aircraft inventory	Flying hours[a] (hundreds per quarter)
TF33-P-7A	C-141B	4	245	686
F100-100	F-15A	2	269	186
F100-100	F-15B	2	49	33
F100-100	F-15C	2	278	224
F100-100	F-15D	2	40	30
F100-100 totals			636	473
F100-200	F-16A	1	521	407
F100-200	F-16B	1	105	85
F100-200	F-16C	1	342	283
F100-200	F-16D	1	46	39
F100-200 totals			1,014	814

[a] Taken from PA87-3 for 4th quarter of FY88.

These engines were selected because they represent both sizable inventory investments and diversity in terms of users, managing organizations, and fundamental maintenance concepts. The TF33 is an older engine (first qualified in 1963) that is managed by the Oklahoma City Air Logistics Center (ALC) for the Military Airlift Command. Both versions of the F100 (qualified in 1973) are managed by the San Antonio ALC for the Tactical Airlift Command. The two engines are thus drawn from different user communities, are managed by different ALCs, and are of differing ages.

[1]Our analysis of the effects of spare engines is drawn from quantifying the BP-15 requirement for FY86. The effect of BP-15 expenditures is not felt until the materiel enters the inventory a procurement leadtime (PLT) later. Since the average PLT takes about 2 years, the FY86 requirement is driven by projected inventories and utilization rates for FY88.

In addition, the F100 is designed under a modular maintenance concept. The entire engine can be replaced in about 4 hours. Bases are equipped to replace modules and to repair only a limited number of engine accessories. With most components, including all the modules, when there is a failure, the defective components are shipped to the San Antonio depot for repair.

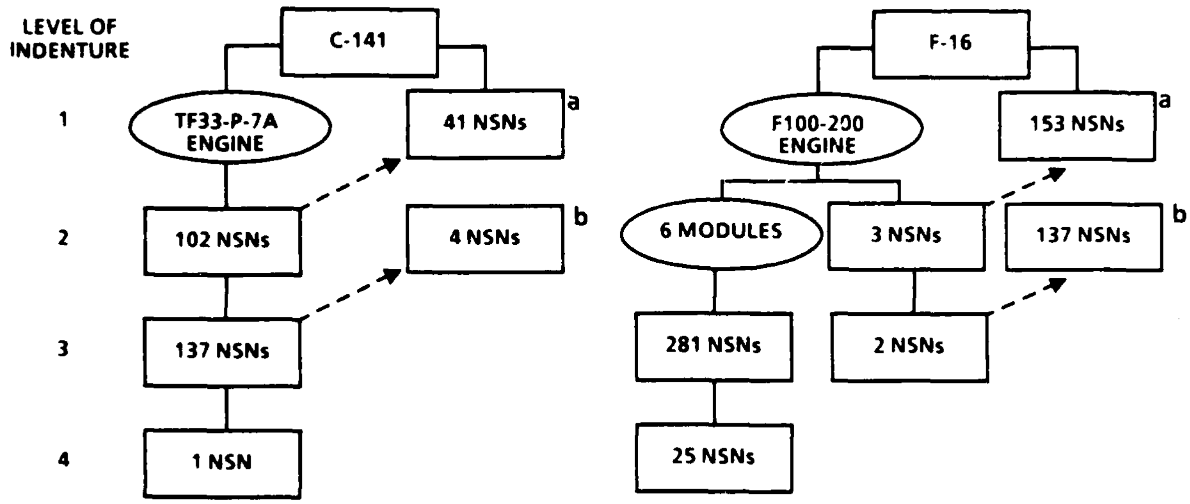
The TF33, a nonmodular engine, is much simpler to maintain. It has fewer components than on the F100, and the maintenance crew on the flight line has far greater access to the entire engine. On the other hand, the age of the TF33 has led to problems related to instability in demand rates, problems that are not as severe as those affecting the relatively new F100.

Extraction of D041 Data

From the D041 data base of September 1985, we selected all components with applications to the weapon systems listed in Table 2-1. Of components that are common to other weapon systems, we designated prorated fractions (based on usage factors) of the demands and assets applicable to the weapon systems of interest. Nondemand-based requirements, such as additive requirements and negotiated levels, were similarly prorated.

The AAM processes components by level of indenture, beginning with the lowest level (now set at Level 5). Level 5 components are processed first, with their demands and resupply times leading to the calculation of expected backorders (EBOs) across all feasible ranges of spares. These backorders are then passed up to their Level 4 parents. This procedure is repeated until Level 1 processing occurs. At this point, the backorder calculations are used to measure each component's contribution to aircraft availability.

At each level, the AAM requires an application file showing all components for that level together with the linkage to the next higher assemblies. Standard AAM preprocessing software was used to construct these application files from the 50 records of the D041 data base. (See [1], [2], and [3] for detailed documentation.) Figure 2-1 shows the number of components by level of indenture for the TF33 and F100-200 engines, specifically those components that are removed and replaced on the flight line. The basis for this identification of the "de facto LRUs" is discussed later in this chapter.



[a] These components are linked to the engine in D041 but were identified as "de facto" LRUs using D049

[b] Components whose next higher assemblies are "de facto" LRUs

FIG. 2-1. COMPONENTS OF TF33, F100 ENGINES

The two engines are very different in their levels of complexity. After reclassification, whole TF33 spare engines have 240 BP-15 constituent subassemblies; the F100-100 and its modules have 311. Moreover, 306 of the F100-200 engine components are protected by two levels (engines and modules) of non-BP-15 stock. Results later in this chapter will show the effects of this difference in complexity on the BP-15 requirement for the corresponding weapon systems.

COLLECTING DATA ABOUT ENGINES AND ENGINE MODULES

Computing Engine Pipelines

Part of the AAM standard preprocessing involves the calculation of pipeline values. Pipelines are defined as the expected number of a given component that are in various segments of resupply. The base repair pipeline, for example, is the expected number of components in base maintenance at a random point in time. Stocks must be procured in part to provide protection for uncertainties in these pipeline quantities. To include engines and engine modules in a BP-15 computation, therefore, it is necessary to compute pipelines for the engines and modules themselves.

Our pipeline calculation method is in accordance with AFLC regulations, as specified in AFM 400-1, *Selective Management of Propulsion Units.* In particular, we used standard and easily accessible Air Force data systems as the source of the required data. These include the *Actuarial Removal Interval (ARI) Tables* as the source of engine removal rates and Technical Order 2-1-18, *Aircraft Engine and Module Management by Operating Limits and Pipeline Times*, as the source of resupply times.

The pipeline computations are therefore compatible with the techniques used to monitor the status of engine inventories. Moreover, the techniques used here on the two engines chosen for analysis are readily extended to an analysis of all the engines in the Air Force inventory. The computed pipeline values used in our study, together with the specifics of the pipeline algorithm, are included in Chapter 3.

Peacetime Engine Assets

Our primary goal is to measure the effect of spare engines on the POS BP-15 requirement. We must therefore input a suitable quantity of spare engine and module assets. One possibility would be to input the existing worldwide inventories, as shown in Column (A) of Table 2-2. As noted earlier, however, requirements and consequently actual inventories of spare whole engines and engine modules are largely driven by *wartime* scenarios. We must determine *peacetime* spares for engines to be used in the POS BP-15 computation. The problem here is analogous to the AAM's treatment of War Reserve Materiel (WRM) assets for BP-15 components. Normally, these assets are not included in the component's asset level. This is consistent with the use of the AAM in computing the *POS* portion of BP-15. Though WRM stocks are frequently drawn on to solve spare shortages in peacetime, it is Air Force policy that WRM stocks not be included in *peacetime* requirements computations. We must therefore know the corresponding quantities of war reserve engine assets to be set aside for our purpose.

TABLE 2-2

ENGINE AND MODULE ASSETS

Engine/module	(A) Current inventory	(B) Minimum stockage objectives	(C) = (A) − (B) Apparent peacetime assets	(D) MIME assets
F100-100	297	115	182	128
Fan	117	21	96	66
Core	165	31	134	92
FDT	99	17	82	70
Augmentor	73	40	33	49
Gearbox	118	35	83	83
HPT	283	43	240	88
F100-200	234	83	151	110
Fan	88	14	74	84
Core	113	15	98	112
FDT	80	10	70	53
Augmentor	40	13	27	32
Gearbox	83	15	68	80
HPT	170	19	151	99
TF33-P-7A	175	101	74	62

For the engines included in our study, we collected the "minimum stockage objectives" for engines and modules that are given to each base by the corresponding Major Command (MAJCOM). Though these levels are not designated "war reserve" assets per se, our visits both to the ALCs and to Air Force bases led to the conclusion that, functionally speaking, these assets have the same purpose as WRM assets for BP-15 components. Consequently, one method of determining the appropriate peacetime asset levels for engines is to subtract these minimum stockage levels from the worldwide inventories and declare the difference [Column (C) of Table 2-2] as representing peacetime requirements. We consider this approach and document its effect in the "Sensitivity Analyses" subsection of this chapter.

We are concerned about this approach to the asset problem because of our impression that the minimum stockage levels as just described are highly subjective; moreover, it does not seem desirable for the BP-15 computation to depend upon MAJCOM judgments concerning war requirements. The volatility of war requirements could cause the resulting peacetime assets to be logically inconsistent with the computation of BP-15 POS requirements.

Instead, we designed special-purpose software for determining peacetime levels of assets. This software constitutes what we call the Multi-Indenture Model Emulator (MIME). This model was designed to emulate the MOD-METRIC model used by AFLC Headquarters in evaluating the total (POS and WRM) requirement for the F100 engine. We ran the MIME (with peacetime factors) and set the target fill rates at 80.5 percent, the standard now applied in AFLC methods for determining propulsion requirements. The resulting peacetime levels of assets are listed in Table 2-2. More details concerning the MIME are presented in Chapter 3.

We recommend use of MIME (or similar software) because we think it is important that the D041 computation be "stand-alone" in character with respect to engine assets. At the same time, it is important that the method for computing peacetime asset levels be compatible with techniques that have been accepted by the propulsion management community. The MIME algorithm satisfies this need.

Engine Indenture Relationships

The application records of the D041 include information about the linkage between engine components and their parent modules or engine. The parent-to-subassembly relationships derived from the D041 for the TF33 and F100 engines are shown explicitly in Appendix B.

The D041 application file (the 50 file) is maintained by item managers and equipment specialists. Its major purpose is to supply data for computing individual item programs (Organizational and Intermediate Maintenance, Engine Overhaul, Programmed Depot Maintenance, and Management of Items Subject to Repair) within the D041 system. Only indirectly and imperfectly does it supply information about detailed maintenance procedures. In particular, the D041 sheds no light on the "de facto LRU" problem, that is, the existence of engine assets that the maintenance crew can remove and replace on the flight line without returning the engine to base maintenance. In most cases, the D041 portrays these items as applied

to the engine, which they are for purposes of item program computation. However, since these items are removed directly from the aircraft upon failure, a levels-of-indenture model must treat them as applied directly to the aircraft (LRUs) rather than to the engines (SRUs).

Identifying these "de facto LRUs" is difficult. To help identify them, we have investigated some rules of thumb. For example, it is generally true that items linked directly to the F100 engine, but not to a module, are accessible on the flight line, and that module components are not. But this rule has its exceptions.

The most promising solution to the problem is the Master Materiel Support Record (D049) system. This is a data base that contains the component/subassembly linkage data by weapon system. Included is a Source of Maintainability and Repair (SMR) Code. The SMR specifically identifies components that are removable on the flight line.

We received three reports from the D049: the Consolidated Full Range of Recoverables (D049.443G, as documented in AFLCR 65-1) for the TF33-P-7A, the F100-100, and the F100-200 engines. To identify the "de facto LRUs," as defined above, we augmented our indenture files with SMR data from the D049.

As a result of our study of these reports, we "raised" a number of engine LRUs to aircraft LRU status. Figure 2-1 shows that 45 TF33 components and 290 F100-200 components were reclassified on the basis of the D049 data.

Thus far, the D049 and D041 have proved compatible in that the stock number listings for the engines analyzed match reasonably well. We understand that the RDB project office is encouraging efforts at the Sacramento ALC to clean up the D049 system. It is the intention of RDB personnel to use the D049 as a source of weapon system application data superior to what is available in the D041. The D049, therefore, seems to be a promising source of information for identifying engine components that can be removed directly from the aircraft.

AAM RESULTS

Sunk-Cost Requirements

We made a preliminary execution of the AAM, "purchasing" all nondemand-based requirements, such as negotiated levels, insurance requirements, and additive

requirements. Also included in this buy were the quantities needed to fill all resupply pipelines. It is Air Force policy to fill the pipelines; i.e., the requirement for a component has the pipeline value as a minimum. Safety levels are *additional* assets that purchase protection against stockouts.

All of these "sunk costs" (purchased without regard to considerations of marginal analysis) are listed by weapon system in Table 2-3. The marginal value of some SRU stocks is so great that they would be purchased for any reasonable level of availability. For the sake of computer efficiency, the AAM automatically makes these investments; this expenditure is labeled "SRU buys" in Table 2-3. These assets were then added to the starting asset position so that subsequent analysis could focus entirely on the safety level portion of the requirement. Put another way: The "buys" listed in Table 2-3 would be purchased by the AAM, whether or not engines are portrayed correctly. Our procedure makes it easier to focus on the difference in the safety level requirements resulting from inclusion of engine assets.

TABLE 2-3

SUNK-COST REQUIREMENTS

(Millions of dollars)

MD	Negotiated levels	Insurance requirement	Pipeline fills	SRU buys	Totals
C-141	$ 5.525	$ 5.596	$ 78.843	$0.616	$ 90.580
F-15	26.293	8.926	566.993	0.052	602.264
F-16	82.457	15.244	542.481	0.077	640.259
Total	114.276	29.765	1,188.316	0.745	1,333.102

Comparison of Safety Levels For Fixed Aircraft Availability

We measured the effects of spare engines and engine modules by contrasting two sets of safety level quantities, as computed by the AAM. The first is the engines-transparent treatment; i.e., *all* first-level engine components are treated as belonging directly to the aircraft. Our alternative treatment includes engine and module assets explicitly. These asset levels [Column (D) of Table 2-2] were determined by means of the MIME software. The indenture relationships were modified from the D041 on the basis of the D049 SMR codes, as described earlier.

Table 2-4 shows the results of this comparison for three different levels of availability.[2] Note that the percentage change in the requirement as a result of including engine assets *decreases as the availability target increases*. Though these results generally indicate that the BP-15 requirement goes down if engines are included, this is a function of the asset levels used in this study. In fact, Table 2-4 shows the opposite result in the case of the C-141 at 90 percent availability. In this case, there are not enough engine assets to cover the engine requirements that have been included in the computation. Engine backorders are reduced by the purchase of *more* of the internal engine components.

The effects of spare engines and modules are clearly greater for the F100 engine than for the TF33. There are two reasons: (1) two added levels of buffering stocks (engines and modules) in the case of the F100 and only one level of stocks for the TF33 and (2) the greater complexity of the F100 engine.

The effects on engine components for the 80 percent availability target[3] are shown in Table 2-5. In addition to the bottom-line change in requirement, the presence of spare engines and modules causes changes in the mix of spares. In the case of the C-141B, for example, the rather modest overall change of 1 percent in total safety level investment is a combination of a 12.3 percent decrease for engine components and a 3.4 percent increase in nonengine components.

Component-specific changes in the requirement can be dramatic. Table 2-6 shows some examples. The second component listed shows the interactive effects of component buys. Though engine spares for the most part reduce the value of every engine component, this particular component becomes a "better buy" (relative to all other possible component buys) when engine assets are included in the availability computation. The F-15/F-16 LRU, shown last, also increases in value when engines are included.

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[2]A given availability target under the "engines transparent" treatment is based upon the assumption that whole engines have neither spares levels nor requirements. The *predicted* availability is therefore different from the availability that would be actually achieved. We believe the comparisons shown in Table 2-4 to be meaningful measures of the effects of including engines because we believe that the availability methods to be introduced into the D041 will be "target driven." We will return to this point at the end of this section.

[3]Throughout the remainder of this report, unless noted otherwise, we use 80 percent as the *target* availability rate for which all AAM results are compared.

TABLE 2-4

EFFECTS OF ENGINE SPARES ON SAFETY LEVEL REQUIREMENTS

(Millions of dollars)

	Availability targets		
	70 percent	80 percent	90 percent
C-141			
Engines transparent	51 35	64 87	87.54
Engines included	50 09	64.40	89.16
Difference	1.26	0.47	- 2.12
Percentage difference	2.5%	0.7%	- 2.4%
F-15			
Engines transparent	136.80	183.63	263.99
Engines included	125.26	172.08	254.93
Difference	11.54	11.55	9.06
Percentage difference	8.4%	6.3%	3.4%
F-16			
Engines transparent	73.42	100.21	149.64
Engines included	65.00	90.24	139.04
Difference	8.42	9.97	10.60
Percentage difference	11.5%	9.9%	7.1%
Totals			
Engines transparent	261 57	348.71	501.17
Engines included	240.35	326.72	483.63
Difference	21.22	21.99	17.54
Percentage difference	8.1%	6.3%	3.5%

Note: In this table and those that follow, *positive* differences correspond to *reductions* in the BP-15 requirement as a result of including engines in the computation

Comparison of Safety Levels for Fixed Investment

The results of the previous section show comparisons of safety-levels for a fixed availability rate target. In particular, the 80 percent target used in the "engines transparent" treatment is a predicted value based on the (incorrect) assumption that first-level engine components are directly installed on the aircraft. Buying according to the engines transparent assumption will result in different availabilities from those we predict because engines and modules, regardless of any modeling assumptions do in fact exist and play a role in the readiness of airplanes.

TABLE 2-5

BREAKOUT OF ENGINE COMPONENT REQUIREMENTS

(80 percent availability target)

	Engine components	Nonengine components	Totals
C-141B			
Engines transparent	18.361	45.966	64.372
Engines included	16.107	47.461	63.568
Difference	2.254	- 1.495	0.759
Percentage difference	12.28%	- 3.25%	1.18%
F-15A/F-16B			
Engines transparent	106.760	173.768	280.528
Engines included	84.183	172.978	257.161
Difference	22.577	0.790	23.367
Percentage difference	21.15%	0.45%	8.33%
Totals			
Engines transparent	125.121	219.734	344.855
Engines included	100.290	220.439	320.729
Difference	24.831	- 0.705	24.126
Percentage difference	19.85%	- 0.32%	7.00%

The comparisons with a fixed availability target are meaningful because we believe the availability methods incorporated into the D041 will be target driven; i.e., the spares levels will be derived from predictions of aircraft availability rates without regard to conceptual differences between predicted availabilities and availabilities that will be achieved. Earlier LMI research [4] on setting availability targets supports this point of view.

A complementary approach is to compare the effects of engines based on the availabilities resulting from a fixed level of investment, rather than the difference in expenditures for a fixed level of (predicted) availability.

TABLE 2-6

ANALYSIS OF INDIVIDUAL COMPONENTS

Name (NSN)	Application	Unit cost	Safety level requirements		Cost difference
			Engines transparent	Engines included	
2 Rotor RC (2840009188399RV)	TF33 (level 1)	$208,582	8	3	$1,042,910
Housing AC (2995002412212RU)	TF33 (level 2)	1,077	17	32	– 16,155
Case assembly (2840011349233PT)	F100 fan	32,199	68	36	1,030,368
Liner assembly (2840011302407PT)	F100 core	56,914	44	26	1,024,452
Case assembly (2840010491150PT)	F100 augmentor	28,639	89	21	1,947,452
Mau 122A (1095011003892)	F-15/F-16 LRU	3,570	72	84	– 42,840

Table 2-7 compares the availabilities under the "engines transparent" and "engines included" assumptions for three levels of approximately equal expenditures. Note that, for technical reasons,[4] it is not possible to make the costs exactly equal in the two model executions.

[4]The availability cost curves are not really curves at all, but a collection of discrete points. This fact, together with the treatment of components common to more than one weapon system, makes it difficult to match expenditures precisely.

TABLE 2-7

COMPARISON OF SAFETY LEVELS FOR APPROXIMATELY EQUAL EXPENDITURES

Case[a]	Engines transparent		Engines included	
	Safety level cost (millions)	Availability	Safety level cost (millions)	Availability
1	$263.37	71 06	$259.39	72 00
2	343.78	79.95	341 48	81 00
3	473 15	88.64	470.27	89 42

[a] Cases 1, 2, and 3 are designed to capture the effects across all three weapon systems (C-141, F-15, F-16) at aggregate availability targets of approximately 70 percent, 80 percent, and 90 percent, respectively

All availabilities shown in Table 2-7 were evaluated with engines included – but the underlying buy quantities listed in "engines transparent safety level" column of the table are derived from the engines transparent treatment. In all cases, the engines included analysis results in more available airplanes per dollar of investment. For example, in case (2), the engines-included treatment achieves a 1 percent increase in availability with $2.3 million less in expenditures than the corresponding engines transparent treatment.

We interpolated along the individual weapon system curves to estimate the change in availabilities for a set of constant expenditures. These are shown in Table 2-8. This table shows that, for the safety-level expenditures shown, to include engines in the requirements computation results in a 2.3 percent increase in availability. This translates to an increase of 34 available aircraft across the three weapon systems for the same level of investment.

SENSITIVITY ANALYSES

Indenture Portrayal

We have investigated the sensitivity of our results to our treatment of the two major issues – the portrayal of engine indenture relationships and the actual inventory levels for spare engines and modules.

On the basis of D049 data (in particular, the SMR data element), we identified the engine components that are removable from the aircraft. Table 2-9 shows the

effects of this modification. The column headed "D041 indenture structure" shows the safety level requirements if the D041 application structure is left as is; the "D041/D049 indenture structure" results refer to the recommended approach of identifying "de facto LRUs" by means of the D049 SMR data. The effects, overall, are relatively minor, but, again, the individual component buy requirements can differ significantly.

TABLE 2-8

WEAPON SYSTEM AVAILABILITY COMPARISON FOR A FIXED EXPENDITURE

MD	Safety level requirements (millions)	Aircraft availability		Difference (percent)	Difference (number of aircraft)
		Engines transparent	Engines included		
C-141	$ 64.73	80.06	80.32	0.3	1
F-15	174.57	79.34	80.55	1.5	8
F-16	104.48	80.45	82.90	3.0	25
Totals	343.78	79.95	81.78	2.3	34

TABLE 2-9

EFFECTS OF INDENTURE PORTRAYAL

(Millions of dollars)

MD	Engines transparent	D041/D049 indenture structure	D041 indenture structure	Difference (percent)
C-141	$ 64.87	$ 64.40	$ 64.22	0.2%
F-15	183.63	172.08	168.44	2.1%
F-16	100.21	90.24	88.92	1.5%
Totals	348.71	326.72	321.58	1.6%

We illustrate this point with a single example. The Unified Fuel Control [(UFC) NSN 2915010645946PT] on the F-15 is accessible for replacement directly on the flight line but is listed in the D041 as applied to the engine. If the AAM is run

without modification of the indenture structure, there is a resulting procurement requirement of 10; if the UFC is treated properly as an aircraft LRU, the requirement is 23. This translates to a difference of $2.2 million.

We think it is important that the indenture be portrayed accurately from the maintenance perspective and that the D049 be used for the purpose. As a matter of fact, the D049 can be used to improve application data, not just for engines but throughout the D041; the result will be an improved BP-15 computation.

Engine Assets

Next, we considered the sensitivity of our results to the engine and module asset levels. As noted earlier, peacetime assets for whole engines and modules could be calculated by subtraction of the Minimum Stockage Objectives (as prescribed by the MAJCOMs) from current inventory levels. In Table 2-10, these are labeled "Apparent peacetime assets." These assets are compared with the assets generated by the MIME model in Table 2-10, where we have consolidated the data for both the F100-100 and F100-200 engines. Note that, with the exception of the F100 Augmentor and Gearbox modules, the apparent inventories available for peacetime usage exceed the MIME-generated requirement. We would expect, therefore, that inclusion of these higher asset levels would lessen the requirement for BP-15 engine components. Table 2-11 shows how this expectation has been borne out.

Table 2-12 shows the effects of changes in asset levels on the set of High Pressure Turbine (HPT) subassemblies. The requirement for turbine blades (NSN 284001133601 7PT) alone changes by $694,000.

To summarize: Including engine and module assets *makes a difference* in the BP-15 computed requirement in both macro and micro senses. The magnitude of the difference depends on the complexity of the engine, the accuracy of the indenture portrayal and most important, the degree to which peacetime asset levels are in balance with requirements. In fact, the magnitude of the difference in today's requirement as a result of including engines is perhaps not so relevant as our conclusion that the effects *can* be large.

Chapter 3 deals with the specifics of incorporating spare engines and engine modules into a D041 computation.

TABLE 2-10

COMPARISON OF ENGINE ASSET LEVELS

	MIME assets	Apparent peacetime assets
F100 Engine	238	333
Fan	150	170
Core	204	232
FDT	124	152
Augmentor	81	60
Gearbox	163	151
HPT	187	391
TF33-P-7A	62	74

TABLE 2-11

SENSITIVITY TO ENGINE ASSET LEVELS

(Requirement for engine components only – in millions of dollars)

Engine	AAM requirements		Difference	Difference (percent)
	MIME assets	Apparent assets		
TF33	$ 16.11	$ 14.25	$ 1.86	11.5%
F100	84.18	68.86	15.32	18.2%
Total	100.29	83.11	17.18	17.1%

TABLE 2-12

THE EFFECTS OF ASSET LEVELS ON HIGH PRESSURE TURBINE COMPONENTS

NSN	Unit cost	Safety level requirements		Cost difference
		MIME[a] assets	Apparent[b] assets	
2840003214570PT	$ 2,172.10	75	40	$ 178,112
2840011201949PT	1,023.10	693	452	455,280
2840011201952PT	1,073.64	345	229	246,937
2840011201953PT	1,024.85	382	243	246,989
2840011240706PT	16,518.11	7	0	280,808
2840011253840PT	350.32	1,560	1,168	257,135
2840011336017PT	705.59	1,758	1,224	694,301
2840011584262PT	19,299.19	31	0	1,235,148
2840011230999PT	2,829.54	72	36	200,897
2840011360472PT	125.18	847	728	31,921
Total				3,827,528

[a] Uses 238 whole F100 engines and 187 spare HPTs.

[b] Uses 333 whole F100 engine and 391 spare HPTs.

CHAPTER 3

STRATEGY FOR IMPLEMENTATION

Chapter 2 summarized the efforts of including engines in the AAM. In this chapter, we detail the techniques that we believe suitable for incorporation into the D041 computation. We include identification of data sources, as well as the algorithms needed for both computing engine pipelines and determining peacetime spares levels for engines and engine modules.

COMPUTING ENGINE PIPELINES

Pipeline Formula

The basic formula for calculating engine pipelines is:

$$\text{PIPELINE} = \text{FHP} \times \text{RR} \times \text{QPA} \times \text{FAP} \times \text{CONVERSION} \times \text{RT},$$

where

PIPELINE = The expected quantity in a particular form of resupply (base repair, depot repair, or order-and-ship)

FHP = The flying-hour program for the component per quarter

RR = The removal rate (in failures per flying hour) corresponding to the pipeline of interest

QPA = Quantity per application, or the number of engines or modules on each aircraft

FAP = Future application percentage, the percentage of aircraft on which the engine or module is installed

CONVERSION = The conversion from quarters to days (1/90)

RT = The average resupply time in days (for either base repair, depot repair, or order-and-ship).

The data sources for each of these factors are listed below. Following that, we provide a step-by-step example of pipeline calculations for the F100-100 engine.

Data Sources

Flying-Hour Data

The aircraft inventory and flying-hour programs by quarter are available in the Aerospace Vehicles and Flying-Hour Program (PA) documents. Extraction of the inventories by base and the flying hours by weapon system is sufficient for pipeline computations and avoids the problem of using the classified base-specific flying-hour data.

Application Data

The QPA and FAP data linking BP-15 components to either their module or engine parents are available in the D041 application records. The QPAs and FAPs corresponding to the applications of engines/modules to the parent aircraft come from a data file maintained by AFLC.

Resupply Times

The base repair time (BRT), depot repair time (DRT), and order-and-ship time (OST) are available in Technical Order 2-1-18. A component of the DRT and the OST is the Overseas/In-Theater transportation time (OS/IT), which varies by location. We recommend weighting these times by the aircraft inventories at each base to obtain an overall average for inclusion in DRT and OST.

Removal Rates

We derived the removal rates by inverting the times between removals (as measured in flying hours) for the engines and modules. Those times between removals are found in the Actuarial Removal Interval (ARI) Tables, published twice each year by the San Antonio and Oklahoma City Air Logistics Centers (ALCs). Specifically, we took the "Overhaul Removal Interval Including Maximum Time Removal" (DEPOHRI) and the "Base Maintenance Removal Interval" (BMRI) from the ARI Tables and inverted them to obtain the depot and base removal rates, respectively.

The Not-Reparable-This-Station (NRTS) rate, the percentage of time a failed item is beyond the capability of base repair, is calculated by division of the depot removal rate by the sum of the base and depot removal rates.

Sample Calculation

Table 3-1 summarizes the data we collected pertaining to the F100-100 engine. This engine is installed on the F-15A, F-15B, F-15C, and F-15D. Total flying hours and numbers of aircraft by base for each type are listed in Table 3-2.

TABLE 3-1

DATA SUMMARY FOR F100-100 ENGINE

Variable name	Description	Source	Value
DEPOHRI	Depot removal interval	ARI Table	2,277 hours
BASBMRI	Base removal interval	ARI Table	151 hours
BRT	Base repair time	T.O. 2-1-18	9.0 days
DRT	Depot repair time	T.O. 2-1-18	52.0 days
O&ST	Order-and-ship time	T.O. 2-1-18	6.4 days
OS/IT	Overseas/in-theater time	T.O. 2-1-18	5.25 days[a]

[a] This is actually the weighted average of the location-specific OS/IT values which were weighted by aircraft inventories at each base. These inventories by base are included in Appendix A.

TABLE 3-2

UTILIZATION DATA FOR F-15 AIRCRAFT

Weapon system	Flying hours per quarter	Aircraft inventory
F-15A	18,000	269
F-15B	3,300	49
F-15C	22,400	278
F-15D	3,000	40
Totals	47,300	636

To compute the required pipeline values, these data can be combined in the following steps:

Daily Flying Hours for Engines:

$$\begin{aligned} \mathbf{DFH} &= (\text{Flying Hours/Quarter}) \times \text{QPA} \times \text{CONVERSION} \\ &= 47{,}300 \times 2 \times (1/90) \\ &= 1{,}051.11 \end{aligned}$$

Daily Demand Rate:

$$\begin{aligned} \mathbf{DDR} &= ((1/\text{DEPOHRI}) + (1/\text{BASBMRI})) \times \text{DFH} \\ &= ((1/2277 + 1/151)) \times 1{,}051.11 \\ &= .0071 \times 1{,}051.11 \\ &= 7.423 \end{aligned}$$

NRTS Rate:

$$\begin{aligned} \mathbf{NRTS} &= (1/\text{DEPOHRI})/((1/\text{DEPOHRI}) + (1/\text{BASBMRI})) \\ &= .00044/.0071 \\ &= 0.062. \end{aligned}$$

Then the pipelines are computed by:

$$\begin{aligned} \text{BASE REPAIR PIPELINE} &= (\text{DDR}) \times (1 - \text{NRTS}) \times (\text{BRT}) \\ &= (7.423)(.938)(9.0) \\ &= 62.65 \\ \text{ORDER-AND-SHIP PIPELINE} &= (\text{DDR})(\text{NRTS})(\text{O\&ST} + \text{OS/IT}) \\ &= (7.423)(0.062)(6.40 + 5.25) \\ &= 5.38 \\ \text{DEPOT REPAIR PIPELINE} &= (\text{DDR})(\text{NRTS})(\text{DRT} + \text{OS/IT}) \\ &= (7.423)(0.062)(52.0 + 5.25) \\ &= 26.43. \end{aligned}$$

The pipelines and demand rates for the engines and modules analyzed in this study are summarized in Table 3-3.

TABLE 3-3

INPUT DATA FOR ENGINE ASSET CALCULATION

	Daily demand rate	NRTS rate	Cost in ($000)	Pipelines			Repair times		
				Base	Depot	O&S	Base	Depot	O&S
F100-100									
Engine	7.42	.06	$3,116	62.65	26.43	5.38	9	57.2	11.6
Fan	1.22	.77	333	1.13	33.03	9.98	4	35.2	10.6
Core	1.51	.92	1,150	0.71	67.09	14.81	6	48.2	10.6
FDT	1.35	.76	234	1.62	28.89	10.89	5	28.2	10.6
Augmentor	2.49	.05	355	18.94	4.98	1.32	8	40.2	10.6
Gearbox	1.21	.95	50	0.12	27.92	12.27	2	24.2	10.6
HPT	1.90	.81	382	2.16	40.40	16.40	6	26.2	10.6
F100-200									
Engine	6.92	.04	$3,275	59.85	15.66	3.24	9	57.5	11.9
Fan	1.34	.82	304	0.98	38.94	11.97	4	35.5	10.9
Core	1.79	.93	1,156	0.76	80.52	18.12	6	48.5	10.9
FDT	0.89	.75	341	1.12	19.02	7.28	5	28.5	10.9
Augmentor	1.09	.04	363	8.33	1.79	.48	8	40.5	10.9
Gearbox	0.09	.98	40	0.04	21.45	9.55	2	24.5	10.9
HPT	2.04	.83	385	2.12	44.75	18.42	6	26.5	10.9
TF33-P-7A									
Engine	1.86	.12	$ 266	36.08	9.69	5.68	22	43.0	25.4

PEACETIME SPARES LEVELS FOR ENGINES AND MODULES

As noted earlier, one difficulty in assessing the effects of spare engines in the POS BP-15 requirements computation is in determining the appropriate number of spare engines and modules available for peacetime usage.

For modular engines, the Air Force uses the MOD-METRIC model [1] for determining the requirement for spare engines and modules. MOD-METRIC finds the mix of engines and modules that minimizes engine backorders for a given

investment. The backorder target is set to be the minimal value for which a ready rate of 80.5 percent is achieved.[1]

Our approach is to use the MOD-METRIC method but with peacetime factors (demand rates and resupply times). For this purpose, we developed a MOD-METRIC emulator called the Multi- Indenture Model Emulator (MIME). MIME was designed to imitate MOD-METRIC, except that it works at an aggregate – rather than at a base-specific – level of detail.

The MIME is written in PASCAL and is designed to run in an IBM-PC-compatible environment. The complete source code is included in Appendix A. We believe that MIME or equivalent software (possibly the actual MOD-METRIC model) should be used to determine the engine asset levels appropriate for inclusion in the BP-15 computation. This procedure ensures that the same factors (in particular, the flying- hour program) are used in generating demand rates for engines as in computing demand rates for BP-15 components. At the same time, the engine levels are being computed in a way that is compatible with the method used by the engine requirements community. We next document some of the more technical aspects of the MIME software.

Data Sources

As documented earlier, Table 3-3 includes the pipeline values required by the MIME. The cost data in Table 3-3 came from actual AFLC MOD-METRIC informational runs in the case of the two F100 engines and associated modules. (The cost of the TF33 shown in Table 3-3 came from unofficial Air Force documents. Its accuracy is not crucial because it is not used in any of the calculations of engine assets.)

[1]The ready rate is, for a given spares level, the probability that the next demand can be filled, i.e., the probability that there is at least one spare available. Ready rate and fill rate are closely connected, in that the ready rate with s + 1 spares is the fill rate with s spares.

Since the MIME and AAM use average bases, we converted the number of bases for each weapon system to an "equivalent" number of average bases. This conversion is based on the formula that was derived empirically in earlier, unpublished LMI research:

$$N_{Adj} = \left(\sum FH_i \right)^2 / \sum \left(FH_i \right)^2,$$

where FH_i is the flying-hour program at the i^{th} (from a total of N) base. Calculation of expected backorders (EBOs) with N_{Adj} homogeneous bases yields approximately the same results as calculations that explicitly consider the heterogeneity expressed by the differing values for FH_i. It is always true that the adjusted number of bases, N_{Adj}, can never exceed N, the number of (possibly nonuniform) bases.

Treatment of Uncertainty

To model the uncertainty in each resupply process, both the AAM and MOD-METRIC use a negative binomial distribution. It is completely specified by the statement of two parameters: the mean μ and variance σ^2, or, equivalently, the mean μ and variance-to-mean ratio (VMR):

$$VMR = \sigma^2/\mu.$$

The mean values are the pipelines, as computed by the method previously described. The MIME applies the same VMR formula as MOD-METRIC:

$$VMR = (1 + 3 \times T/91),$$

where T is the resupply time corresponding to the pipeline under consideration. See [2] for documentation concerning this formula.

MIME Accuracy and Validation

We validated the MIME model by comparing its results with those of a PC version of the AAM and the AFLC MOD-METRIC model. On the basis of these and other tests, we concluded that the MIME produces engine asset levels consistent with MOD-METRIC but with a technique that does not require base-specific data input.

ENGINE INDENTURE RELATIONSHIPS

We have recognized that the D041 application data describes imperfectly the indenture relationships of aircraft components. In this study, we were especially interested in identifying engine components that are directly removable from the aircraft. We used the SMR Code of the D049 system to identify these items. The third position of the SMR Code indicates the level of maintenance where the component can be replaced. Specifically, this position takes three values:

- "O" to indicate replacement capability at the *organizational* level, that is, on the flight line
- "F" to indicate replacement capability at the *intermediate* (base) level of maintenance
- "D" to indicate replacement capability at the *depot*.

Thus, those elements coded "O" are replaceable on the flight line.

We received three reports from the D049: the Consolidated Full Range of Recoverables (D049.443G as documented in AFLCR 65-1) for the TF33-P-7A, the F100-100, and the F100-200 engines. We used the SMR data to identify the "de facto LRUs," as defined before.

We started with the indenture file as identified by the D041 and "bumped" engine components to LRU status if their SMR designation was an "O" or if they were missing from the D049 report.[2] In the case of the TF33, 41 of the 143 first-level engine components were reclassified. For the F100 engine, 153 of the 156 first-level engine components were reclassified. None of the module components were bumped; this is consistent with the fact that module repair for the F100 is performed exclusively at the San Antonio depot.

MODIFICATIONS TO AAM CODE

Inclusion of engines necessitated some changes in the AAM software. Foremost among them is the change required to prevent the AAM from "buying" engines or engine modules. Accordingly, engine backorders can be reduced only by an increase in the spares levels for the BP-15 engine components. The technical

[2]The presumption here is that the item was missing from the D049 engine report because the D049 considered it to be directly applied to the aircraft.

details of how this is accomplished are peculiar to the AAM code and are not given here, although analogous changes in the D041 availability model should be easy to implement.

Second, although the AAM used the standard AFLC VMR for BP-15 components:

$$\mathbf{VMR} = \mathbf{a} \cdot \left(\mathbf{PIPELINE} \right)^{\mathbf{b}}, \text{ where } \mathbf{a} = 1.132 \text{ and } \mathbf{b} = 0.341,$$

we modified the AAM to use the MOD-METRIC formula for engines. Other than these two changes, the AAM code itself was left unchanged.

CHAPTER 4

CONCLUSIONS AND RECOMMENDATIONS

Our analysis shows that the proper treatment of engine assets can change significantly the safety level requirements for BP-15 components. With an availability target of 80 percent, for example, the total requirement decreases by approximately 7 percent, and the requirement for engine components alone decreases by 20 percent. Individual component requirements often change by more than 40 percent.

The magnitude of the difference is sensitive to engine requirements, engine asset levels, and the complexity of the engine. The key result, however, is not the magnitude of the change in the BP-15 requirement for a particular weapon system at a specific point in time, but the fact that the requirements *can change in either direction* from the comparable results obtained without consideration of engine assets. Inclusion of engines improves the accuracy of both the budgetary requirement and the predicted readiness that will result from a given budget.

We have also indicated the specific ways in which the effects of engines can be incorporated into the availability methods now being introduced into D041. The methods we recommend are not hard to implement, and our study shows that increased accuracy in the resulting BP-15 requirements would justify the effort involved.

Availability methods are preferred because they measure the worth of a specific spare to aircraft readiness. Failure to include engines properly in the parts hierarchy distorts the value of engine components to the aircraft and thus undermines the very advantage that availability methods offer.

We recommend, therefore, that AFLC incorporate spare engines and engine modules into its D041 computation of the POS BP-15 requirement. Implementation of this recommendation should take place as close as possible to the introduction of availability methods into D041.

Specific steps toward accomplishing this goal include:

- Designing "stand-alone" software to be used to set peacetime asset levels for engines and modules. This includes collecting the data required for computing engine pipelines. The data sources and pipeline computation method have been identified in this report. The engine requirement software could be adapted from the MIME (source code in Appendix A) or from AFLC's MOD-METRIC model.
- Using the D049 as the source of weapon system application data. In particular, the SMR Code of the D049 should be used to portray the indenture relationships of weapon-system components from the maintenance perspective.

Actually, the Requirements Data Bank (RDB) project office is already involved in efforts to build weapon-system application files from the D049. AFLC should encourage this effort and, in particular, encourage use of SMR Codes. AFLC should use the results of this study to point out the inaccuracy that results from the failure to portray engine assets properly.

AFLC should encourage more communication between those responsible for BP-15 requirements (AFLC/MMMR) and those responsible for engine requirements (AFLC/MMMAE). The result could be a better understanding of the peacetime requirements for engine assets and a better balance in requirements between engines and engine components.

A stated goal of the RDB project is integration of the BP 15 and BP 16 requirements computations. Incorporation of engine assets into the D041 would not only yield more accurate BP-15 requirements projections but would serve as an important first step toward an integrated computation. In particular, the D041, with engines included, would be capable of assessing the balance between the requirements for whole engines and engine components.

REFERENCES

Chapter 1

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[3] DoD Supply Management Policy Group. *Secondary Weapon System Management*. May 1985.

Chapter 2

[1] LMI Report AF201. *The Aircraft Availability Model: Conceptual Framework and Mathematics*. O'Malley, T. J. Jun 1983.

[2] LMI. *The Aircraft Availability Model User's Manual*. Arnberg, Robert L. May 1984.

[3] LMI Report AF501R4. *The Aircraft Availability Model Analyst's Manual*. Arnberg, Robert L. Nov 1986.

[4] LMI Working Note AF401-2. *Setting Aircraft Availability Targets*. Hanks, Christopher H. Feb 1985.

Chapter 3

[1] Muckstadt, John A. "A Model for a Multi-Item, Multi-Echelon, Multi-Indenture Inventory System," *Management Science*. Vol. 20, pp. 472-81. Dec 1973.

[2] Air Force Logistics Command. *Recoverable Inventory Control Using MOD-METRIC*. AFLCP 57-1. Sep 1973.

APPENDIX A

MULTI-INDENTURE MODEL EMULATOR (MIME): DESCRIPTION AND SOURCE CODE

OVERVIEW

This is the PASCAL program for the Multi-Indenture Model Emulator (MIME). The MIME emulates the AFLC MOD-METRIC model, which calculates peacetime sparing levels for engines and their modules. At present, the MIME has one LRU (the engine) and six SRUs (the engine modules). The MIME has six basic program procedures to handle the multi-echelon (depot and base), multi-indenture (LRU and SRUs) condition:

- INPUT_DATA. This procedure contains all the input information for the LRU and each of its SRUs required by the MIME: The depot pipeline, the base plus order-and-ship pipelines, the Not-Reparable-This-Station (NRTS) rate, the total daily demand rate for all bases, and the cost. The estimated average number of bases is also required.

- DO_ALL_EBOS. This procedure is the crux of the MIME, calculating total pipelines, variance-to-mean ratios (VMRs), and expected backorders (EBOs) at the depot or base. The procedure also determines the distribution of spares between the depot and base that minimizes EBO at the base for all significant sparing levels. The significant sparing level is the range of spares from 1 to x, where PDF(x) > 0.0005.

- CONVEXIFY_DELTAEBO_COST. Under this procedure, as SRU spares increase, there is a decrease in the difference (delta) of EBO divided by cost (EBO/cost); that is, the delta-EBO/cost to spares curve is convex. If the delta-EBO/costs does not decrease between spares levels, the procedure clumps spares together until that condition is met.

- DO_LSWORTHS. This procedure combines all six SRUs into one sorted list. The list is sorted in descending order by delta-EBO/cost for each spare level or clump. The procedure then combines the spares into groups of SRUs whose total cost equals the cost of an LRU, termed an LsWorth.

- CMP_LRU_LSWORTH. This procedure combines the depot LRU with LsWorths and ranks them by delta-EBO/cost reduction; that is, for an

additional LRU cost at the base, the procedure determines whether it is better to buy an LRU for the depot or a number of SRUs (an LsWorth).

- FIND_BESTEBO_RR. This procedure finds the minimum spares level with a ready rate (CDF) greater than or equal to the target ready rate of 80.5 percent. Once the base LRU EBO calculations have been minimized for all sparing levels, this procedure searches these results until the minimum spares level with a ready rate of 80.5 percent or greater is found. The procedure then breaks down that base spare level into LRUs at the base and depot and the total number of each of the SRUs represented by that ready rate.

PROGRAM FLOW/PSEUDO-CODE

This section shows how the procedures just discussed were sequenced together to form the MIME. The pseudo-code or program flow is used to describe the sequencing. The pseudo-code is similar to the actual main program section of the MIME presented at the end of this section. For the pseudo-code, words in capital letters represent the actual procedure name.

```
{MAIN PROGRAM}
BEGIN
   INPUT_DATA;
   repeat  for each SRU, find base/depot combination that
   minimizes EBOs.
      DO_ALL_EBOS for the sparing levels at the depot.
      repeat  for each depot spare EBO value
          DO_ALL_EBOS for the sparing levels at the base.
      until all depot levels are done
      CONVEXIFY DELTAEBO/COST of  the  SRU  for  all  spares
                              at base
   until all SRUs are done.
   DO_LSWORTHS calculation combining all SRUs.
   DO_ALL_EBOS  for LRU sparing levels at the depot.
   CMP_LRU_LSWORTH (rank LRU depot spares with Lsworths).
   repeat for all depot/lsworth EBO spare levels
      DO_ALL_EBOS for all LRUs sparing levels at the base
   until all depot levels are done
   FIND_BESTEBO_RR (find spare level with a ready rate of
                    80.5%.)
END. {MAIN PROGRAM}
```

SOURCE CODE

The MIME source code follows. Included (in Procedure INPUT_DATA) are the values for all the required data elements for engines as discussed in Chapter 3.

```
CONST
   PROGRAM MIME;
   DIMBESTEBO=800; {the dimension of the BESTEBO array}
   DIMSPARE=400; {the dimension of the spare arrays}
   DEPOT=1;   {access index to depot info in arrays}
   BASE=2;    {access index to base info in arrays}
   REBO=2;    {EBO index}
   DIMSRU=6; {the maximum no. of srus for a parent}
   HIVAL=9999; {Initialization value}
TYPE
   {each record contains pertinent info. for each SRU & the LRU
   MODULEPTR=^MODULEREC;
   MODULEREC=RECORD
       MODNO:INTEGER; {module number}
       NAME:STRING[15];   {module name }
       DDR:REAL;        {daily demand rater}
       NRTS:REAL;       {not repairable this station, % to depot}
       COST:REAL;  {unit cost of module}
       EBO: ARRAY[1..2,0..DIMSPARE] OF REAL; {no. at depot and best
                        base EBO for base, rows 1 & 2 respectively}
       PIPELINE: ARRAY[1..2]OF REAL;  {the depot demand * repair and
                        the base+order/ship time* total  base demand.
                        Notice the depot pipeline is total demand
                        from all bases (NRTS*DDR) while the base is
                        the total base demand (1-NRTS*DDR ) and
            will later be divided by the no. of  bases.}
       MAXSPARES:ARRAY[1..2] OF INTEGER;{no. of spares at which PDF=0}
       CHILD:  ARRAY[1..DIMSRU] OF MODULEPTR;  {pointers to the
                        modules sub-components or SRUs}
   END;{record type}

VAR
   LRU,MOD1,MOD2,MOD3,MOD4,MOD5,MOD6,CHILDPTR:MODULEPTR;
   DEPSPARE:INTEGER; {index to count spares at depot}
   NCHILD:INTEGER;  {index to srus or children of LRU}
   BESTEBO:ARRAY[1..4,0..DIMBESTEBO] OF REAL; {stores best or lowest EBO
             of all base/depot combinations for constant total spares
             1=depspares,2=ebo,3=cdf,4=vmr/q}

   {next 2 below in procedure DO_LSWORTHS}
   LSWORTH:ARRAY[1..DIMSRU,0..DIMSPARE] OF REAL; {rows are the SRUs,
           columns are the no. of SRUs for that particular
           lsworth (i.e. col index}
   LSEBOCOST: ARRAY[1..2,0..DIMSPARE] OF REAL;  {rows are the total
            cost and total ebo for the lsworth, i.e. column}
   TOTLRLS:ARRAY[1..3,0..DIMSPARE] OF REAL; {total ebo, lru no. &
           lsworth }   ROW,COL:INTEGER;
```

```
MAXLSWTH:INTEGER; {Maximum no. of lsworths for overflow check}
NBASE:INTEGER; {no. of bases, varies for each engine}
ENGINE_NAME:STRING[60];
RRTOT,RRDEPOT,RRBASE:INTEGER; {best RR answer total depot and
           base spares}
FLEET:INTEGER;  {no. of aircraft in fleet for engine}
QVMR:REAL; {the variance to mean ratio for negative binomial}
```

```
PROCEDURE INPUT_DATA;
{inputs depot and base/os pipeline, daily demands, NRTS input
 and initializes all modules}
BEGIN
   {creates LRU/SRU relationship in a tree like manner}
   NEW(LRU);     NEW(MOD1);     NEW(MOD2);     NEW(MOD3);
   NEW(MOD4);    NEW(MOD5);     NEW(MOD6);
   LRU^.CHILD[1]:=MOD1;  LRU^.CHILD[2]:=MOD2; LRU^.CHILD[3]:=MOD3;
   LRU^.CHILD[4]:=MOD4;  LRU^.CHILD[5]:=MOD5; LRU^.CHILD[6]:=MOD6;
   LRU^.NAME:='LRU';     MOD1^.NAME:='MOD1';  MOD2^.NAME:='MOD2';
   MOD3^.NAME:='MOD3';   MOD4^.NAME:='MOD4';  MOD5^.NAME:='MOD5';
   MOD6^.NAME:='MOD6';

   FOR ROW:=1 TO DIMSRU DO
      LRU^.CHILD[ROW]^.CHILD[1]:=NIL;

   { PASCAL      PIPELINES  F15 F100-100
                 DEPOT    BAS+OS          DAILY DR     NRTS
    ENGINE       26.43     68.03              7.42    0.0622
    1 FAN        33.03     11.11              1.22    0.7680
    2 CORE       67.09     15.52              1.51    0.9217
    3 TURB       28.89     12.52              1.35    0.7593
    4 AUGM        4.98     20.26              2.49    0.0496
    5 GEAR       27.92     12.39              1.21    0.9501
    6 HPT        40.40     18.56              1.90    0.8104}

   {ENGINE SPECIFIC DATA FOR THE F15 F100-100}
   {FINAL ENGINE RUNS  7/28/86}
    {depot and base total pipeline data, i.e. from all bases}
     {base pipeline=base+ost pipes}
   LRU^.PIPELINE[DEPOT]:= 26.43;     LRU^.PIPELINE[BASE]:=68.03;
   MOD1^.PIPELINE[DEPOT]:=33.03;   MOD1^.PIPELINE[BASE]:=11.11;
   MOD2^.PIPELINE[DEPOT]:=67.09;   MOD2^.PIPELINE[BASE]:=15.52;
   MOD3^.PIPELINE[DEPOT]:=28.89;   MOD3^.PIPELINE[BASE]:=12.52;
   MOD4^.PIPELINE[DEPOT]:= 4.98;   MOD4^.PIPELINE[BASE]:=20.26;
   MOD5^.PIPELINE[DEPOT]:=27.92;   MOD5^.PIPELINE[BASE]:=12.39;
   MOD6^.PIPELINE[DEPOT]:=40.40;   MOD6^.PIPELINE[BASE]:=18.56;
    LRU^.DDR:=7.42;                   LRU^.NRTS:= 0.0622;
   MOD1^.DDR:=1.22;                 MOD1^.NRTS:= 0.7680;
   MOD2^.DDR:=1.51;                 MOD2^.NRTS:= 0.9217;
   MOD3^.DDR:=1.35;                 MOD3^.NRTS:= 0.7593;
   MOD4^.DDR:=2.49;                 MOD4^.NRTS:= 0.0496;
   MOD5^.DDR:=1.21;                 MOD5^.NRTS:= 0.9501;
   MOD6^.DDR:=1.90;                 MOD6^.NRTS:= 0.8104;
   NBASE:=10;
   FLEET:=473;
   WRITELN('NO. OF AIRCRAFT IN FLEET IS ',FLEET);
   ENGINE_NAME:='--------FOR THE F15 (7/28) F100-100--------';
   WRITELN('ENGINE TYPE IS ',ENGINE_NAME,'  with bases = ',NBASE);

   LRU^.COST:=3.116000;   MOD1^.COST:=0.333400;  MOD2^.COST:=1.150000;
   MOD3^.COST:=0.233700;   MOD4^.COST:=0.355200;  MOD5^.COST:=0.049900;
   MOD6^.COST:=0.382450;
END;{procedure INPUT_DATA}
```

```
PROCEDURE GLOBAL_INITIALIZE;
{Global data initialized w/in}
BEGIN
  RRTOT:=9999;
 END;{Procedure global_initialize}




PROCEDURE INITIALIZE_DATA;
VAR
   ROW,COL:INTEGER;
BEGIN

   FOR COL:=0 TO DIMBESTEBO DO
     BEGIN
       BESTEBO[1,COL]:=HIVAL;
       BESTEBO[2,COL]:=HIVAL;
       BESTEBO[3,COL]:=HIVAL;
     END;
END;
```

```
{BACKGROUND INFORMATION FOR EBO CALCULATION}

    {NOTE 1 *************************************************************
           {Total base pipeline=BRPIPE+OSTPIPE+EBO(depot)}
           {EBO(depot) is a collapsed form of
            EBO(x)/EBO(0)*(DDR*DRT*NRTS)
               where
                     BRPIPE is base pipeline (1-NRTS)DDR*BRT)
                     OSPIPE order and ship pipe (NRTS*DDR*OST)
                     EBO(x) is the expected backorder w/ x spares
                     EBO(0) is mean LambdaT (DDR*DRT*NRTS)
                     DRT is the depot repair rate
                     DDR is the total daily demand at each base
                     NRTS is the % of demand sent to depot
            this model defines depot and base demand seperately
            (i.e. after NRTS is considered and deals with total
            depot and base demands.  Other documentation uses DDR
            the daily demand rate as the demand at a single base
            some of which gets diverted or NRTSed to the depot.
            Hence the depot sum is (NRTS*DDR*bases).
    *************************************************************}


    {Note 2 *******************************************************
    PDF(X)=(LAMBDAT**X)*(EXP(-LAMBDAT)/X!

       PDF(0)=0
       PDF(1)= (LAMDAT/1)*(EXP(-LAMBDAT)
       PDF(2)= (LAMDAT*LAMBDAT/2*1)(EXP(-LAMBDAT)
             = (LAMBDAT/2)*PDF(1)
       PDF(X)= (LAMBDAT/X)*PDF(X-1)

    EBO(X)=SUM(X>S) for (X-S)*PDF(X) expected backorders of X assumes
       a spare level of S=X-1
    SPARES
    LEVEL
     2     EBO(2)-EBO(3)=PDF(2)+PDF(3)*1 + PDF(4)*1 ....ETC
     2     EBO(2)-EBO(3)= (1-CDF(1))
     2     EBO(3)= EBO(2)-(1-CDF(1))
     X-1   EBO(X)= EBO(X-1)-(1-CDF(X-2))
            WITH
             CDF(X-2)=CDF(X-3)+PDF(X-2)
           OR  the DAAM's method
     X-1   EBO(X)=EBO(X-1)-(RCDF)
           RCDF=RCDF-PDF(X-2)
    **************************************************************}
```

PROCEDURE DO_ALL_EBOS(MODPTR:MODULEPTR;ECHELON:INTEGER);
The procedure determines the best distribution of spares between the depot and base that minimizes EBO at the base for all significant sparing levels. The significant sparing level is the range of spares from 1 to x where PDF(x)>0.0005.

```
VAR
   PDF:REAL;  {probability of X=SPARES, p(x=s)}
   CDF:REAL;  {cummulative probability}
   TMODMET:REAL; {repair time used in VMR calculation for Mod-METRIC}
   EBOTEMP:REAL; {dummy variable to temporarily store current EBO value}
   SPARES:INTEGER;  {number of spares at echelon}
   PIPE:REAL;    {the pipeline or lamda*T mean for poisson distribution}
   ROW:INTEGER;

BEGIN
  WITH MODPTR^ DO
   BEGIN
   IF ECHELON=DEPOT
      THEN
        BEGIN
         PIPE:=PIPELINE[DEPOT];
         TMODMET:=PIPE/(NRTS*DDR);
        END
      ELSE {do base+os pipe + ebo delay for base}
        BEGIN
         IF (MODPTR^.CHILD[1]=NIL)
            THEN {Total base pipeline=BRPIPE+OSTPIPE+EBO(depot)/no.
                 of bases.  See note 1}
             PIPE:=(MODPTR^.PIPELINE[BASE]+MODPTR^.EBO[DEPOT,DEPSPARE])
                   /NBASE
            ELSE {is identure & do best of lru and lsworth}
              PIPE:=(MODPTR^.PIPELINE[BASE]+TOTLRLS[1,DEPSPARE])/NBASE;
         TMODMET:=PIPE/(DDR/NBASE);
       END;{else}
   END;{WITH}

  {PDF(X)=(LAMBDAT**X)*(EXP(-LAMBDAT)/X! See note 2}

   {VMR from modmetric runs and dependent on repair times, T modmet}
   QVMR:=1+((3*TMODMET)/91);
   EBOTEMP:=PIPE;
   SPARES:=0;
   IF (QVMR=1.0)
      THEN {Poisson distribution}
         PDF:=EXP(-PIPE)
      ELSE {Negitive binomial distribution}
         {PDF:=Q**(-PIPE/Q-1)}
         PDF:=EXP(-(PIPE/(QVMR-1))*LN(QVMR));
   CDF:=PDF;
```

```
{CONTINUATION OF PROCEDURE DO_ALL_EBOS}

   REPEAT  {calculates EBOs for each spare level}
      IF ECHELON=DEPOT
         THEN {store ebos for base calculation}
           BEGIN
            MODPTR^.EBO[DEPOT,SPARES]:=EBOTEMP;
           END
         ELSE {print and check
          to see BESTebo for spare level}
            BEGIN
               IF (BESTEBO[2,(NBASE*SPARES+DEPSPARE)]>EBOTEMP*NBASE)
                  THEN {insert current ebo as best}
                    BEGIN
                     BESTEBO[2,(NBASE*SPARES+DEPSPARE)]:=EBOTEMP*NBASE;
                     BESTEBO[1,(NBASE*SPARES+DEPSPARE)]:=DEPSPARE;
                     BESTEBO[3,(NBASE*SPARES+DEPSPARE)]:=CDF;
                     BESTEBO[4,(NBASE*SPARES+DEPSPARE)]:=QVMR;
                    END;
            END;{IF}
      SPARES:= SPARES+1; {EBO(SPARES+1)=EBO(X)}
      {EBO(X)=EBO(X-1)-(1-CDF(X-2))}
      EBOTEMP:=EBOTEMP-(1-CDF);
      {EBO:=EBO-RCDF daam's method}
      {PDF(X-1) = PDF(X-2)*PIPE/X-1 = PDF(X-1)*PIPE/SPARES}
      {PDF(X):=PDF*((Q-1)/Q)*((X+(PIPE/(Q-1))-1)/X
       see pg D-7 AAM math framework document      }
      PDF:=PDF*(((((QVMR-1)/QVMR)*(SPARES-1))+(PIPE/QVMR))/SPARES);
      {CDF(X-1)=CDF(X-2)+PDF(X-1)}
      CDF:=CDF+PDF;
   UNTIL (SPARES>PIPE) AND (PDF<0.0005);
      {for the first few spares PDF maybe very small, so need to
       keep going for at least pipe tries.  Once move through much
       of the PDF then small values (<.0005) means you've done enough}

     {store maximum spares required for echelon for later use}
    MODPTR^.MAXSPARES[ECHELON]:=SPARES-1;
    IF (ECHELON=DEPOT) OR (DEPSPARE=0)
       THEN
          WRITELN('NAME ECHELON MAXSPARES ',MODPTR^.NAME,ECHELON:5,
          SPARES-1:7);
END;{procedure DO_ALL_EBOS}
```

```
PROCEDURE CONVEXIFY_DELTAEBO_COST(CHILDPTR:MODULEPTR);
{this procedure starts at the bottom of the BESTEBO matrix and works its way
up, determining the delta EBO/cost and whether its convex or < then next
lower spare level.  If it is less than, it combines the two and stores it in
lowest spare level.}

VAR
   MAXDIM:INTEGER;  {starting point for doing convexity}
   LAST:INTEGER;    {Index to store last point of convexity}
   COL:INTEGER;
   NEXT:INTEGER;    {Index of next valid ebo for lower spare level}

   PROCEDURE CHECK_CONVEX_BELOW;
   {once clumps have been made going up the array, this may cause
    del ebo/cost immediately below not to be convex.  This procedure
    reverses direction and checks del ebo/cost values already calculate
    (i.e. below) to ensure they are still convex}

   VAR
      BELOW:INTEGER;
      DONE:BOOLEAN;
   BEGIN
   WITH CHILDPTR^ DO
    BEGIN
      DONE:=FALSE;
      WHILE (NOT DONE) AND (LAST<MAXDIM) DO
       BEGIN
         BELOW:=LAST;
              REPEAT {looking for a valid del ebo/cost value}
                BELOW:=BELOW+1;
              UNTIL (EBO[BASE,BELOW]<>HIVAL);
         IF (BELOW>MAXDIM) OR (EBO[BASE,LAST]>EBO[BASE,BELOW])
            THEN {at bottom of matrix or value below is still convexed}
               DONE:=TRUE
            ELSE {value below not convexed, must be merged}
              BEGIN
               EBO[BASE,BELOW]:=(BESTEBO[REBO,NEXT]-BESTEBO[REBO,BELOW])/
                                       ((BELOW-NEXT)*COST);
               EBO[BASE,LAST]:=HIVAL;
               LAST:=BELOW;
              END;
      END; {WHILE}
   END;{with}
   END;{sub-Procedure CHECK-CONVEX-BELOW}
```

```
{CONTINUATION OF PROCEDURE CONVEXIFY_DELTAEBO_COST}

BEGIN
COL:=DIMBESTEBO+1;
{find 1st valid ebo value}
REPEAT
   COL:=COL-1;
UNTIL (BESTEBO[REBO,COL]<>HIVAL);
WITH CHILDPTR^  DO
BEGIN
MAXDIM:=COL;
IF  MAXDIM>DIMSPARE
   THEN {change max dimension & print warning}
    BEGIN
       WRITELN('SRU SPARING LEVEL TRUNCATED TO MAX SPARE CONSTANT');
       MAXDIM:=DIMSPARE;
    END;
EBO[BASE,0]:=BESTEBO[REBO,0]; {w/ spares=0, has no delta ebo}
LAST:=MAXDIM; {to ensure first test for convexity is with in array}
COL:=MAXDIM;
REPEAT
   NEXT:=COL-1;
   {skip over invalid spare values, from impossible dep/base combos}
   WHILE  BESTEBO[REBO,NEXT]=HIVAL DO
    BEGIN
      {skip entry & store default}
      EBO[BASE,NEXT]:=HIVAL;
      NEXT:=NEXT-1;
    END;{while}
   {Store delta ebo and spares at depot, respectively}
   EBO[BASE,COL]:=(BESTEBO[REBO,NEXT]-BESTEBO[REBO,COL])/COST;
   EBO[DEPOT,COL]:=BESTEBO[DEPOT,COL];
   {check for convexity}
   IF EBO[BASE,COL]>EBO[BASE,LAST]
      THEN {convexity, or strictly monotone decreasing function}
         LAST:=COL
      ELSE {No convexity, or find slope of 2 end points, combining
             current value and recalculating last slope  }
        BEGIN
          {Calculate slope, or delta ebo over delca cost}
          EBO[BASE,LAST]:=(BESTEBO[REBO,NEXT]-BESTEBO[REBO,LAST])/
                                              ((LAST-NEXT)*COST);
          EBO[BASE,COL]:=HIVAL;
          CHECK_CONVEX_BELOW;
        END;
     COL:=NEXT;
   UNTIL (COL=0);
END;{WITH}
END;{procedure convexity_ebo_cost}
```

```
PROCEDURE DO_LSWORTHS;
{this procedure sorts all the SRUs delta ebo/cost values then groups
 them into to LSWORTHs, ending with a total ebo, total cost, and no.
 of each SRU for each lsworth}
CONST
      SPARE=1;UNIT=2;DELTA=3; {column indices for SRUDAT}
      RCOST=1;REBO=2; {row index for LSEBOCOST}

VAR
   SRUDAT:ARRAY[1..DIMSRU,1..3] OF REAL; {rows are SRUs, w/ columns
             being the spare no., no. of additional spares from
             last spare no., delta ebo/cost value for the spare no.}
   LSWTH:INTEGER; {column index for LSWORTH and LSEBOCOST}
   TOTEBO:REAL;
   ROW,COL,MAX:INTEGER;
   DCOST:REAL; {the incremental cost of the next sru clump}
   FRAC:REAL; {fractional part of clump to make lswth complete}

   PROCEDURE FIND_NEXT(NCHILD:INTEGER);
   {this procedure finds the next valid SRU clump, EBO value,
    and number of units in clump}
   VAR
     NUNIT,COL:INTEGER;
   BEGIN
      NUNIT:=0;
      COL:=TRUNC(SRUDAT[NCHILD,SPARE]);
      REPEAT
         NUNIT:=NUNIT+1;
         COL:=COL+1;
      UNTIL (LRU^.CHILD[NCHILD]^.EBO[BASE,COL] <>HIVAL);
      SRUDAT[NCHILD,SPARE]:=COL;
      SRUDAT[NCHILD,UNIT]:=NUNIT;
      SRUDAT[NCHILD,DELTA]:=LRU^.CHILD[NCHILD]^.EBO[BASE,COL];
   END; {procedure find_next}
PROCEDURE INC_EBO_COST_SRU(FRAC:REAL);
{this procedure adds the appropriate additional increment of EBO,
 Cost, and no. of SRU spares for each LSWORTH.  When only a
 fraction of a clump or SRU is added. The fraction is FRAC}
 BEGIN
    {ebo is changed from deltaebo/cost to delta ebo}
    LSEBOCOST[REBO,LSWTH]:=LSEBOCOST[REBO,LSWTH]
                          +(SRUDAT[MAX,DELTA]*DCOST*FRAC);
    LSEBOCOST[RCOST,LSWTH]:=LSEBOCOST[RCOST,LSWTH]+(DCOST*FRAC);
    LSWORTH[MAX,LSWTH]:=LSWORTH[MAX,LSWTH]+(SRUDAT[MAX,UNIT]*FRAC);
END;{procedure INC_EBO_COST_SRU}
BEGIN
   {****INITIALIZE******}
   FOR ROW:=1 TO DIMSRU DO
     BEGIN
        SRUDAT[ROW,SPARE]:=0;
        SRUDAT[ROW,UNIT]:=0;
        SRUDAT[ROW,DELTA]:=0;
     END;
```

```
{CONTINUATION OF PROCEDURE DO_LSWORTHS}
   FOR ROW:=1 TO DIMSRU DO
      FOR COL:=0 TO DIMSPARE DO
        LSWORTH[ROW,COL]:=0;
   FOR ROW:=1 TO 2 DO
      FOR COL:=0 TO DIMSPARE DO
         LSEBOCOST[ROW,COL]:=0;
  WITH LRU^ DO
     BEGIN
        TOTEBO:=0;
        {sum total ebos, store in spare level 0, for all srus}
        FOR ROW:=1 TO DIMSRU DO
           TOTEBO:=TOTEBO+CHILD[ROW]^.EBO[REBO,0];
        LSEBOCOST[REBO,0]:=TOTEBO;
        WRITELN('TOTAL EBO FOR 0 SPARES ALL SRUS ',TOTEBO:10:4);
        LSWTH:=1;
        {enter spare values 1 into SRUDAT}
        FOR ROW:=1 TO DIMSRU DO
           FIND_NEXT(ROW);
  {***** END INITIALIZE *****}
        REPEAT
           MAX:=1;
           FOR NCHILD:=2 TO DIMSRU DO
              IF SRUDAT[NCHILD,DELTA]>SRUDAT[MAX,DELTA]
                THEN {switch sru w/ max or best delta ebo/cost}
                   MAX:=NCHILD;
           {incremental cost SRUs=no. of units times unit cost}
           DCOST:=SRUDAT[MAX,UNIT]*CHILD[MAX]^.COST;
           {if cost of next srus makes lsworth totcost>then cost of LRU}
           IF (DCOST+LSEBOCOST[RCOST,LSWTH])>(COST*LSWTH)
              THEN {start w/ next lsworth}
                 BEGIN {adds a fraction of the clump to make lswth
                    equal to LRU cost exactly}
                    FRAC:=((COST*LSWTH)-LSEBOCOST[RCOST,LSWTH])/DCOST
                    INC_EBO_COST_SRU(FRAC);
                    SRUDAT[MAX,UNIT]:=SRUDAT[MAX,UNIT]*(1-FRAC);
                    { tot ebo(N) - tot ebo(n-1)= del ebo for LSWTH}
                    LSEBOCOST[REBO,LSWTH]:=LSEBOCOST[REBO,LSWTH-1]
                                            -LSEBOCOST[REBO,LSWTH];
                    {prepares for next LSWTH}
                    LSWTH:=LSWTH+1;
                    LSEBOCOST[RCOST,LSWTH]:=LSEBOCOST[RCOST,LSWTH-1];
                    FOR ROW:=1 TO DIMSRU DO
                       LSWORTH[ROW,LSWTH]:=LSWORTH[ROW,LSWTH-1];
                 END
              ELSE {add entire clump to lsworth & find next clump}
                 BEGIN
                    INC_EBO_COST_SRU(1);
                    FIND_NEXT(MAX);
                 END;
        UNTIL (SRUDAT[MAX,DELTA]<=0) OR (LSWTH=DIMSPARE);
         MAXLSWTH:=LSWTH;
      END;{WITH}
   END;{procedure DO_LSWORTH}
```

```
PROCEDURE CMP_LRU_LSWORTH;
{compares the LRU and Lsworth delta ebo value for each additional spare,
 chooses the best (max) and subtracts from the preceding total ebo
 value.  At end of procedure has total ebo value used in lru base pipe,
 total depot spares, and total lsworth for each spare level.}

CONST
   TEBO=1;TDEP=2;TLSW=3; {row index for TOTLRLS matrix, represents
           total ebo, total depot spares, and total lsworth spares,
            respectively}

VAR
   DELLSW,DELDEP:REAL; {the delta ebo values for next additional spare
           for lsworth, depot respectively}
   SPARE:INTEGER; {counter for no. of lru + lsw}
   DCOL,LCOL:INTEGER; {index to next lru or lsworth spare,respectively}

BEGIN
   WITH LRU^ DO
    BEGIN
       {***INITIALIZE********}
       SPARE:=0;
       DCOL:=2; LCOL:=2;
       TOTLRLS[TDEP,0]:=0;
       TOTLRLS[TLSW,0]:=0;
       TOTLRLS[TEBO,0]:=EBO[DEPOT,0]+LSEBOCOST[REBO,0];
       DELDEP:=EBO[DEPOT,0]-EBO[DEPOT,1];
       DELLSW:=LSEBOCOST[REBO,0]-LSEBOCOST[REBO,1];
       {main part of procedure}
       REPEAT
          SPARE:=SPARE + 1;
          IF DELDEP>=DELLSW
             THEN {next spare added is an lru from depot}
              BEGIN
                TOTLRLS[TEBO,SPARE]:=TOTLRLS[TEBO,SPARE-1]-DELDEP;
                TOTLRLS[TDEP,SPARE]:=TOTLRLS[TDEP,SPARE-1]+1;
                TOTLRLS[TLSW,SPARE]:=TOTLRLS[TLSW,SPARE-1];
                DELDEP:=EBO[DEPOT,DCOL-1]-EBO[DEPOT,DCOL];
                DCOL:=DCOL+1;
              END
             ELSE {next spare added is an lsworth }
              BEGIN
                TOTLRLS[TEBO,SPARE]:=TOTLRLS[TEBO,SPARE-1]-DELLSW;
                TOTLRLS[TDEP,SPARE]:=TOTLRLS[TDEP,SPARE-1];
                TOTLRLS[TLSW,SPARE]:=TOTLRLS[TLSW,SPARE-1]+1;
                DELLSW:=LSEBOCOST[REBO,LCOL-1]-LSEBOCOST[REBO,LCOL];
                LCOL:=LCOL+1;
              END;
       UNTIL (((DELDEP<=0) AND (DELLSW<=0)) OR (SPARE=DIMSPARE));
       MAXSPARES[DEPOT]:=SPARE;
       WRITELN('MAXSPARES ARE ',MAXSPARES[DEPOT]:8);
   END;{WITH}
END; {procedure CMP_LRU_LSWORTH}
```

```
PROCEDURE FIND_BESTEBO_RR;
{finds the bestebo(lowest value) with ready rate greater than .805 and
 w/ the minimum number of total lrus/lsworths. The procedure starts
 at top of bestebo matrix and moves down, to higher total spares
 until the CDF or ready rate is greater than .805 or RRVALUE}
CONST
  RRVALUE=0.805;

VAR
   COLDEP,COL:INTEGER;
   BESTRR:INTEGER; {the location of total spares with the best ebo
   and ready rate (RR)}
   NOANSWER:BOOLEAN;
   AVAIL:REAL;
BEGIN
   NOANSWER:=TRUE;
   BESTRR:=0;
   WHILE NOANSWER DO
      BEGIN
         IF ((BESTEBO[3,BESTRR]>=RRVALUE)AND(BESTEBO[3,BESTRR]<>HIVAL))
            THEN {have found the answer}
               NOANSWER:=FALSE
            ELSE
               BESTRR:=BESTRR+1;
      END;{while}
  COL:=TRUNC(BESTEBO[DEPOT,BESTRR]);
  COLDEP:=COL;
  WRITELN;
  WRITELN('FINAL RESULTS FOR  READY RATES USING BEST EBO ');
  IF ((COLDEP<=MAXLSWTH) OR (TOTLRLS[3,COLDEP]<=LRU^.MAXSPARES[DEPOT]))
     THEN
        WRITELN('DIMENSION TRUNCATION OK for max lru dep & lswths',
          LRU^.MAXSPARES[1]:7,MAXLSWTH:5)
     ELSE
       BEGIN
         WRITELN('########ERROR###########################');
         WRITELN('DIMENSION EXCEEDED FOR  max lru dep OR lswths',
          LRU^.MAXSPARES[1]:7,MAXLSWTH:5);
       END;
  WRITELN('TOTDEP, EBO, DEPOT AND  LSWORTH FOR DEP SPARE LEVEL');
  WRITELN(COL:5,TOTLRLS[1,COL]:10:4,TOTLRLS[2,COL]:5:0,
   TOTLRLS[3,COL]:5:0);
  WRITELN;
  WRITELN('LSWTH  LRUEBO  LSEBO  LSWORTH  1    2   3   4    5   6');
  WRITE(COL:4,LRU^.EBO[DEPOT,COLDEP]:9:4,LSEBOCOST[REBO,COL]:9:4);
  FOR ROW:=1 TO DIMSRU DO
     WRITE(LSWORTH[ROW,COL]:5:0);
  WRITELN;
  WRITELN('(TOT DEPOT LRU/LSWTH+BASE)  TOTEBO  AVAIL  DEPSPARES');
  AVAIL:=EXP(-(BESTEBO[REBO,BESTRR]/FLEET))*100;
  WRITELN(BESTRR:5,BESTEBO[REBO,BESTRR]:8:3,AVAIL:8:2,
  BESTEBO[DEPOT,BESTRR]:8:0);
```

```
{CONTINUATION OF PROCEDURE FIND_BESTEBO_RR}

  WRITELN;
  WRITELN('**************************************************************');
  WRITELN('ENGINE TYPE IS ',ENGINE_NAME);
  WRITELN('NUMBER OF AVERAGE BASES   = ',NBASE );
  WRITELN('NO. OF AIRCRAFT IN FLEET IS ',FLEET);
  WRITELN(' TOTAL LRUs =',((BESTRR-COL)+TOTLRLS[2,COL]):4:0);
  COL:=TRUNC(TOTLRLS[3,COL]);
  WRITELN('MODULES   1     2     3     4     5     6');
  WRITE('SPARES');
  FOR ROW:=1 TO DIMSRU DO
     WRITE(LSWORTH[ROW,COL]:6:0);
  WRITELN;
  WRITELN('TOTAL EXPENDITURES IN MILLIONS = ',BESTRR*LRU^.COST:7:1);
  WRITELN('READY RATE =',BESTEBO[3,BESTRR]*100:7:2);
  WRITELN('Q OR VARIANCE TO MEAN RATIO IS',BESTEBO[4,BESTRR]:7:3);
  WRITELN('LRU BASE EBOs  ',BESTEBO[REBO,BESTRR]:8:3,
          '  AVAILABILITY',AVAIL:8:2);
  WRITELN('TOTAL DEPOT SPARES  LRUs  &  LSWORTHS');
  WRITELN(COLDEP:10,'        ',TOTLRLS[2,COLDEP]:5:0,
   TOTLRLS[3,COLDEP]:9:0);
 WRITELN('**************************************************************');

END; {procedure Find_bestebo_rr}
```

```
{MAIN PROGRAM SECTION}
BEGIN
   INPUT_DATA;
   GLOBAL_INITIALIZE;
   INITIALIZE_DATA;
   NCHILD:=1;
   REPEAT    {do all SRUs }
      DEPSPARE:=0;
      CHILDPTR:=LRU^.CHILD[NCHILD];
      {do each SRU}
      INITIALIZE_DATA;
      DO_ALL_EBOS(CHILDPTR,DEPOT);
      REPEAT
          DO_ALL_EBOS(CHILDPTR,BASE);
          DEPSPARE:=DEPSPARE+1;
      UNTIL (DEPSPARE>CHILDPTR^.MAXSPARES[DEPOT]);
      {store the delta ebo/cost & ensure convexity}
      CONVEXIFY_DELTAEBO_COST(CHILDPTR);
      NCHILD:=NCHILD+1;
   UNTIL (CHILDPTR=NIL) OR (NCHILD>DIMSRU);
   DO_LSWORTHS;
   DO_ALL_EBOS(LRU,DEPOT);
   CMP_LRU_LSWORTH;
   INITIALIZE_DATA;
   DEPSPARE:=0;
   REPEAT
      DO_ALL_EBOS(LRU,BASE);
      DEPSPARE:=DEPSPARE+1;
   UNTIL (DEPSPARE>LRU^.MAXSPARES[DEPOT]);
   FIND_BESTEBO_RR;
END. {MAIN PROGRAM}
```

APPENDIX B

INDENTURE REPORTS FOR TF33-P-7A AND F100 ENGINES

These are the component application data taken from the D041 for the three engines analyzed. In addition, we show the safety level requirements for each component, using either the (1) engines transparent or (2) engines included assumptions.

This is the format for these data:

NSN	=	National stock number of the component. Each subassembly is indented beneath its next higher assembly.
Name	=	The D041 nomenclature for the component.
QPA	=	Quantity per application.
FAP	=	Future application percentage, the percentage of next higher assemblies containing this component.
COST	=	Unit procurement cost for the item.
SL_T	=	Safety level requirement under the engines transparent treatment.
SL_E	=	Safety level requirement under the engines included treatment.
DELTA $	=	Dollar value of the difference in requirements.
	=	(SL_T - SL_E) x COST

Pages B-2 through B-7 contain the TF33 report and pages B-8 through B-20 contain the F100 report. The F100 report is a consolidated listing of components on both the F100-100 and F100-200 engines. All costs and safety level requirements reflect the usage on both engine types.

If an item was not required under either assumption, these last four items are left blank. [*Note*: An asterisk (*) appears to the left of every NSN identified by the D049 as an item that is removed and replaced on the flight line. The "engines included" AAM run treated these items as installed directly on the aircraft.]

NSN	NAME	QPA	FAP	COST	SL_T	SL_E	DELTA $
TF0033007A	ENGINE	4	1.00				
2840000035607RV	HSG NR5BRG	1	1.00	2561.34	79	70	23052.06
2840000035608RV	SPT =5 BRG	1	1.00				
2840000151677RV	2 ROTOR FC	1	1.00				
2840000151678RV	3BLADESET2	15	1.00				
2840001151606RV	VANE SHR4	2	1.00	7600.50	21	18	22801.50
2840001573633RV	3BLADE SET	17	1.00				
2840001763734RV	3 DISK 7	1	1.00				
2840002399734RV	3VANE+SHR3	2	1.00	7582.12	23	16	53074.84
2840002800453RV	3 DISK 5	1	1.00				
2840002862143RV	3 DISK 8	1	1.00				
2840007757520RV	3 HUB N1 F	1	1.00				
2840008478148RV	3SPACER 1S	1	1.00				
2840009663010RV	3 AIR SEAL	1	1.00				
2840009663021RV	3 DISK =2	1	1.00				
2840009665038RV	3 DISK 5	1	1.00				
2840009665067RV	3 DISK 8	1	1.00				
2840009665068RV	3 SPACER 2	1	1.00	7247.20	4	0	28988.80
2840009668032RV	3 DISK 6	1	1.00				
2840009668083RV	3SPACER5ST	1	1.00	1702.80	78	70	13622.40
2840009668084RV	3SPACER6ST	1	1.00				
2840009668085RV	3SPACER4ST	1	1.00				
2840009668086RV	3SPACER3ST	1	1.00				
2840009668087RV	3SPACER7ST	1	1.00	1127.78	60	53	7894.46
2840009668088RV	3SPACER8ST	1	1.00				
2840009668096RV	3BLADEINC2	15	1.00				
2840009668111RV	3DISK 3STG	1	1.00				
2840009670367RV	3 DUCT N1	1	1.00	6935.32	1	0	6935.32
2840009802669RV	3HUB RE N1	1	1.00				
2840009819220RV	3DISK STG9	1	1.00				
2840009819230RV	3CASE RFAN	1	1.00	10859.62	7	6	10859.62
2840009831132RV	3CASE FNDS	1	1.00				
2840009831133RV	3VNE,SHRD3	2	1.00				
2840009831174RV	3 DUCT	1	1.00				
2840009875806RV	2VANE 4SHD	2	1.00	4412.00	22	18	17648.00
2840009913738RV	3DISK 4STG	1	1.00				
2840009917613RV	3VNE/SHRD1	1	1.00				
2840009819231RV	3CASE FNFT	1	1.00				
2840010338236RV	3COMPRSTA2	1	1.00	14481.19	13	10	43443.57
2840011453802RV	3SPACER IS	1	1.00				
8145010705772RV	CONTAINER	1	1.00				
2840000154188RV	2ROTOR LST	1	1.00	118989.46	7	6	118989.46
2840001373889RV	3SPACER TU	1	1.00				
2840004399249RV	3BLADESETT	54	1.00				
2840005296202RV	3BLADESET2	57	1.00				
2840006228310RV	3DISK T 3S	1	1.00				
2840008781311RV	3SHAFNITRB	1	1.00	10819.11	19	18	10819.11
2840009663013RV	3HUB TUR 6	1	1.00	3108.42	52	50	6216.84
2840009668045RV	SEAL TRB 3	1	1.00				
2840009668073RV	3DISK TUR2	1	1.00	14500.68	40	37	43502.04
2840009668076RV	SEAL TRB 4	1	1.00				
2840009670373RV	MISSING	1	0.05				

NSN	NAME	QPA	FAP	COST	SL_T	SL_E	DELTA $
2840009873757RV	3BLADESET4	40	1.00	346.90	469	462	2428.30
2840010180303RV	3 SEAL T4S	1	1.00	2072.27	32	31	2072.27
2840010991805RV	3BLADESET3	54	1.00				
2840011480687RV	DISKT OC2S	1	1.00				
2840011480688RV	DISKT OC4S	1	1.00				
2840011484265RV	DISKT OC3S	1	1.00				
2840011484271RV	DISKT OC4S	1	1.00				
2840011484274RV	DISKT OC4S	1	1.00				
2840011603198RV	DISK 4 STC	1	1.00	4970.26	41	40	4970.26
* 2840000192220RV	SEAL 3 BRG	1	1.00				
2840000214994RV	2 SPT=5BRG	1	1.00				
2840000669925RV	2 HSG=1BRG	1	1.00				
2840000716169RV	2CASE RC 1	1	1.00				
2840000792509RV	RING TURB4	1	1.00	3285.76	70	66	13143.04
2840001363018RV	2PUMP4/5SV	1	1.00				
2840001690191RV	CLAMP	8	1.00				
* 2840001753993RV	KIT KF	1	1.00				
2840001758163RV	2ROTOR HST	1	1.00	53712.48	12	11	53712.48
2840001507416RV	3BLADESETT	65	1.00	250.58	624	624	0.00
2840002399738RV	SHAFT2TURB	1	1.00				
2840009833135RV	3DISK T 1S	1	1.00				
2840009871701RV	3SEATTSEAL	1	1.00	415.43	12	12	0.00
2840011480684RV	DISKT1S OC	1	1.00				
2840011480686RV	DISKT OC3S	1	1.00				
2840002263900RV	RING TURB3	1	1.00				
* 2840002263901RV	SEALFACEAS	1	1.00	442.77	64	65	-442.77
2840002437740RV	2 DUCT CC	1	1.00	13963.12	45	40	69815.60
2840002560880RV	VANE 1 STG	3	1.00	146.35	208	203	731.75
2840002560894RV	VANE 1 STG	11	1.00	146.35	509	498	1609.00
2840002560928RV	VANE 1 STG	12	1.00	146.35	644	625	2780.65
2840002561016RV	VANE 1 STG	14	1.00	146.35	762	741	3073.35
2840002561081RV	VANE 1 STG	13	1.00	146.35	719	697	3219.70
2840002561093RV	VANE 1 STG	12	1.00	146.35	566	548	2634.30
2840002561113RV	VANE 1 STG	9	1.00	146.35	428	418	1463.50
2840002561172RV	VANE 1 STG	2	1.00				
2840002561204RV	VANE 1 STG	1	1.00				
* 2840002885402RV	RING TURB2	1	1.00				
* 2840004117764RV	SEGMENT LW	1	1.00				
2840004328887RV	SEGMENT UP	1	1.00				
2840006178169RV	2 GEARBOX	1	1.00	94220.30	11	8	282660.90
2840004921458RV	3 HSGGBDBR	1	1.00	549.88	84	84	0.00
2840009668077RV	3 HSG GB F	1	1.00	14641.96	3	3	0.00
2840010162043RV	3 HSG GB R	1	1.00	13145.56	29	29	0.00
3040007661251RV	3 GEARSHAF	1	1.00				
4320009438325RV	PUMP MAIN	1	1.00	4065.13	2	2	0.00
* 2840007659965RV	NUT 4 1-2	1	1.00	1311.03	93	94	-1311.03
* 2840007682096RV	SPT 2 SEAL	1	0.25				
* 2840007682099RV	ADAPTER AY	1	1.00				
2840007877806RV	2HSG=6 BRG	1	1.00				
* 2840007898463RV	HSG 2 1-2B	1	1.00				
* 2840008067855RV	D+B ASY 3R	1	1.00				
2840006228310RV	3DISK T 3S	1	1.00				

NSN	NAME	QPA	FAP	COST	SL_T	SL_E	DELTA $
2840010991805RV	3BLADESET3	54	1.00				
2840008168578RV	SUPPORT	1	1.00				
2840008285212RV	COM CHBR 5	1	1.00	2540.30	35	31	10161.20
2840008285214RV	COM CHBR23	2	1.00	2529.63	38	33	12648.15
2840008285217RV	COMCHBR678	3	1.00	2932.69	61	55	17596.14
2840008285218RV	COM CHBR 1	1	1.00				
2840008285226RV	COM CHBR 4	1	1.00				
* 2840008333845RV	SEALFACEAY	1	1.00	765.53	70	70	0.00
2840008364162RV	VANE 3 STG	1	1.00				
2840008364166RV	VANE 3 STG	1	1.00				
2840008478150RV	RING TURB3	1	0.95				
* 2840008671472RV	RING 2 ST	1	0.50				
* 2840008688895RV	SUPPORT AY	1	1.00				
* 2840009064754RV	SPT 5 SEAL	1	1.00	2852.48	5	5	0.00
* 2840009093406RV	SPT 2 SEAL	1	1.00	630.31	32	32	0.00
* 2840009101886RV	SEAL 5 WET	1	1.00	765.84	52	52	0.00
2840009120107RV	2 IGV CASE	1	1.00				
2840000697569RV	3 CASE INL	1	1.00				
2840000759427RV	3 DUCT INL	1	1.00				
* 2840009158354RV	2 HSG=4BRG	1	1.00				
* 2840009178102RV	SEAL 4 WET	1	1.00				
2840009188399RV	2 ROTOR RC	1	1.00	208582.45	8	310	42912.24
2840001662356RV	3 BLADE 12	75	1.00	53.93	180	180	0.00
2840001662357RV	3 BLADE 13	75	1.00	47.82	155	155	0.00
2840002224164RV	3 BLADE 11	75	1.00	54.40	176	176	0.00
2840002430356RV	3 DISK =13	1	1.00	1844.76	54	54	0.00
2840002430362RV	3DISKSTG14	1	1.00	8511.33	58	58	0.00
2840002430363RV	3DISKST 15	1	1.00				
2840002430367RV	3DISKSTG16	1	1.00				
2840002640941RV	3 DISK =13	1	1.00				
2840002695147RV	DISK ST 16	1	1.00	1900.00	3	3	0.00
2840002800454RV	3DISK GT14	1	1.00				
2840008216301RU	BLADE ST15	85	1.00	87.08	321	321	0.00
2840008224834RU	BLADE ST14	85	1.00	96.72	269	269	0.00
2840009111035RV	3HUBFTRCN2	1	1.00				
2840009113075RV	3HUBRERCN2	1	1.00				
2840009477113RU	BLADE ST10	73	1.00	54.36	191	191	0.00
2840009477114RU	BLADE+ST11	75	1.00				
2840009477115RU	BLADE+ST12	75	1.00				
2840009663003RV	3CASE CPN2	1	1.00	5035.20	27	27	0.00
2840009663008RV	SEAL	1	1.00				
2840009668107RV	3 TUBE	1	1.00				
2840009819204RV	3 BLADE 16	77	1.00	48.48	217	217	0.00
2840009819208RU	BLADE+ST13	75	1.00				
2840009819209RV	3DISK ST12	1	1.00	2345.25	76	76	0.00
2840009819210RV	3DISK ST11	1	1.00	2462.15	30	30	0.00
2840009819211RV	3DISK ST10	1	1.00				
2840009871695RV	3 SEAT	1	1.00	869.34	41	41	0.00
2840009875798RV	3SPACER14S	1	1.00	2238.48	23	23	0.00
2840009875801RV	3SPACER11S	1	0.68				
2840009875802RV	3SPACER12S	1	1.00	2220.26	22	22	0.00
2840009913733RV	3SPACER10S	1	0.73				

NSN	NAME	QPA	FAP	COST	SL_T	SL_E	DELTA $
2840009913734RV	3 SPACER	1	1.00	2272.66	29	29	0.00
2840009913735RV	3SPACER15S	1	1.00				
2840010041802RV	3VANE/SD10	1	1.00	5227.72	38	38	0.00
2840010045771RV	3VANE/SD11	1	1.00	8924.64	16	16	0.00
2840010045772RV	3VANE/SD15	1	1.00	17149.20	50	50	0.00
2840010045773RV	3VANE/SD14	1	1.00	15841.62	49	49	0.00
2840010045774RV	3VANE/SD12	1	1.00	5840.51	1	1	0.00
2840010051882RV	3VANE/SD13	1	1.00	16634.64	42	42	0.00
2840010401900RV	3SPACER11S	1	1.00				
2840010401901RV	3SPACER10S	1	1.00				
8145010705771RV	CONTAINER	1	1.00				
* 2840009215256RV	SEAL 3 BRG	1	0.40				
2840009215257RV	2 HSG21-2B	1	1.00				
2840009391518RV	2 CASE DIF	1	1.00				
2840009621255RV	VANE 3 STG	16	1.00				
* 2840009621256RV	VANE 4 STG	28	1.00				
2840009621259RV	VANE 3 STG	19	1.00				
2840009621260RV	VANE 3 STG	22	1.00				
2840009621261RV	VANE 3 STG	29	1.00				
2840009621262RV	VANE 3 STG	12	1.00				
* 2840009621263RV	VANE 4 STG	25	1.00				
* 2840009621264RV	VANE 4 STG	24	1.00				
* 2840009621265RV	VANE 4 STG	20	1.00				
* 2840009621266RV	VANE 4 STG	1	1.00				
2840009662986RV	2 SHRD EXA	1	1.00	1610.61	22	18	6442.44
2840009663018RV	CASECCINNR	1	1.00	10083.97	2	1	10083.97
2840009663027RV	VANE 2 STG	14	1.00				
2840009663028RV	VANE 2 STG	18	1.00				
2840009663029RV	VANE 2 STG	24	1.00	228.94	436	420	3663.04
2840009663030RV	VANE 2 STG	19	1.00	235.20	235	221	3292.80
2840009665061RV	2SHRD3 TUR	1	1.00	3133.93	48	45	9401.79
2840009668034RV	SEAL TURBI	1	1.00	712.57	18	15	2137.71
2840009668035RV	SUMP 6BRG	1	1.00	3363.74	15	14	3363.74
2840009668039RV	2SHRD 2TUR	1	1.00	5314.33	32	29	15942.99
2840009668074RV	2SHRD4 TUR	1	1.00	5640.30	59	55	22561.20
2840009668081RV	VANE 2 STG	9	1.00				
2840009670363RV	2DUCT 16ST	1	1.00				
2840000669911RV	3 SHROUD	1	1.00				
* 2840009670371RV	SUPORT ASY	1	1.00				
2840009673951RV	CASE TURB	1	1.00	12212.48	10	8	24424.96
* 2840009783010RV	2 HSG =2 B	1	1.00				
* 2840009802666RV	SEALFACE=2	1	1.00				
2840009815975RV	2 SPT FRT	1	1.00				
2840009819198RV	2CASECCREA	1	1.00				
2840009819226RV	CASE FT CP	1	1.00	8290.03	26	25	8290.03
2840009831148RV	1 TANK OIL	1	1.00	7165.88	25	22	21497.64
2840009831160RV	2CASECCFRT	1	1.00	6626.67	12	11	6626.67
2840009831162RV	SPT ASSYGB	1	1.00				
2840009870610RV	TEE A-I	1	1.00	1255.66	99	95	5022.64
2840009913732RV	STRUT ASY	1	1.00	12966.34	22	20	25932.68
2840010041794RV	VANE/SHRD8	2	1.00				
2840010041796RV	VANE/SHRD5	2	1.00	4315.77	77	72	21578.85

NSN	NAME	QPA	FAP	COST	SL_T	SL_E	DELTA $
2840010041797RV	VANE/SHRD7	2	1.00	3373.15	45	39	20238.90
2840010042179RV	VANE/SHRD6	2	1.00	3295.20	55	49	19771.20
2840010180302RV	RING TURB3	1	1.00				
2840010364842RV	SHROUD T 1	1	1.00				
* 2840010959528RV	3 HUB+BLD	1	1.00	58814.60	7	7	0.00
* 2840001573633RV	3BLADE SET	17	1.00	2599.39	189	171	46789.
* 2840007757520RV	3 HUB N1 F	1	1.00				
* 2840011091578RV	3D+B ASYT4	1	1.00				
* 2840009873757RV	3BLADESET4	40	1.00				
* 2840011603198RV	DISK 4 STG	1	1.00				
2840011195321RV	SEAL ASSY	1	1.00				
2840011244760RV	RING TURB2	1	1.00	913.22	58	55	2739.66
2840011244768RV	RING TURB2	1	1.00				
* 2840011606493RV	CASE T NOZ	1	1.00				
2915000618889RV	1 MANIF LH	1	1.00				
2915008497757RV	4NOZZE ASY	24	1.00				
2915000618892RV	1MANIFD RH	1	1.00				
2915008497757RV	4NOZZE ASY	24	1.00				
2915008722644RV	1HEATR ASY	1	1.00				
2915009663041RV	4 HOUSNG	1	1.00				
* 2915009060119RV	DIST FUEL	1	1.00	3368.05	33	34	-3368.05
2915009125993RV	1 CONTROL	1	1.00				
2915000754045RV	4 HOUSING	1	1.00				
2915002244131RV	4 CAGE VAL	1	1.00				
2915007557528RV	4 HOUSING	1	1.00				
2915007968875RV	4HSNG ASSY	1	1.00				
2915008309574RV	4LEVER F B	1	1.00				
2915010197562RV	4 LEV+BRKT	1	1.00				
2915010197563RV	4 BRKT/IMS	1	1.00				
2915009796646RV	VAL,FUELSO	1	1.00	1687.67	1	0	1687.67
2915009913742RV	1FILTER AY	1	1.00	6172.78	5	5	0.00
5930000661738RV	SWITCH ASY	1	1.00				
2915009913743RV	1 VALVE PD	1	1.00				
2925004567627RV	1 EXCITER	1	1.00				
2925009391473RV	1 CABLE	1	1.00	1057.93	32	31	1057.93
2935008393707RV	1COOLERASY	1	1.00				
2935000566101RV	4HSNG ASSY	1	1.00				
2935000660833RV	CORE ASSY	1	1.00				
2935008070915RV	4 TEMP REG	1	1.00				
2945009968330RV	2 FILTR AY	1	1.00	3482.58	12	12	0.00
2945009802909RV	3 HOUSING	1	1.00	2532.46	6	5	2532.46
2995000879914RV	1 CTR REST	1	1.00	3807.88	28	27	3807.88
2995002321491RV	1 CONTROL	1	1.00	2824.61	58	56	5649.22
2995002325023RU	HOUSING AC	1	1.00				
2995002412212RU	HOUSING AC	1	1.00	1076.63	17	32	-16149.45
2995004342222RV	4 HOUSING	1	1.00				
2995004417052RV	4 PISTONAY	1	1.00				
2995004356898RV	1 CONTROL	1	1.00				
2995002325023RU	HOUSING AC	1	1.00				
2995002412212RU	HOUSING AC	1	1.00				
2995004342222RV	4 HOUSING	1	1.00				
2995004417052RV	4 PISTONAY	1	1.00	361.19	59	59	0.00

NSN	NAME	QPA	FAP	COST	SL_T	SL_E	DELTA $
2995004389890RV	1 ACTUATOR	2	1.00	1723.41	28	25	170.23
2995007658154RV	1 VALVE BP	1	1.00				
2995009067535RV	REGULATOR	1	1.00	852.89	45	43	1705.78
* 2995009372090	STARTER	1	1.00				
2995009914153RV	1VALVE A-I	1	1.00	1832.43	3	3	0.00
* 3110000076911RV	BEARING 1	1	1.00				
* 3110001037244RV	BEARING 1	1	1.00	811.27	139	140	-811.00
* 3110001037246RV	BEARING 3	1	0.99				
3110007283831RV	BEARING 3	1	1.00				
3110008582659RV	BEARING 4	1	1.00	2398.39	32	28	9593.56
3110008582674RV	BEARING 2	1	1.00	3095.34	65	61	12381.36
3110008649269RV	BEARING 5	1	1.00	2612.76	26	22	10451.04
3110008649404RV	BEARING 6	1	1.00	626.77	119	115	2507.08
3110008682742RV	BRNG 4 1-2	1	1.00	1263.89	48	45	3791.67
* 3110010188100RU	BRNG 2 1-2	1	1.00	686.09	131	133	-1372.18
* 4320009171083RV	PUMP FUEL	1	1.00				
* 4320009621276RV	PUMP FUEL	1	1.00				
4320009665026RV	PUMP 6SCAV	1	1.00				
* 4320009831170RV	PUMP ISCAV	1	1.00				
4810009102917RV	1VALVBLEED	1	1.00				
4820005055342RU	4BODY ASSY	1	1.00				
4810009102918RV	1VALVBLEED	1	1.00	5825.77	11	11	0.00
4820005055342RU	4BODY ASSY	1	1.00	3545.52	7	7	0.00
4820000110360RV	1VALFUELAI	1	1.00	1725.62	16	15	1725.62
* 8145008440050RV	ENG CNTR	1	1.00				
* 8145010188215RV	CONTAINER	1	1.00				

	NSN	NAME	QPA	FAP	COST	SL_T	SL_E	DELTA $
	F0100-100/200	ENGINE	2	1.00				
*	2840002926302PT	MANIFLD AY	1	1.00	1844.63	140	140	0.00
*	2840003214566PT	CONE ASY	1	1.00	1880.58	68	68	0.00
*	2840003214594PT	MANIFLD AY	1	1.00	761.45	34	34	0.00
*	2840003214598PT	MANIFLD AY	1	1.00	308.57	80	80	0.00
*	2840003265956PT	MANIFOLD	1	1.00	163.77	71	71	0.00
*	2840003265961PT	MANIFLD AY	1	1.00				
*	2840003266096PT	MANIFOLD	1	1.00				
*	2840003266150PT	MANIFLD AY	1	1.00				
*	2840003266453PT	MANIFLD AY	1	1.00				
*	2840003275433PT	MANIFOLD	1	1.00				
*	2840003275452PT	MANIFOLD	1	1.00	10024.78	61	61	0.00
*	2840003374706PT	COUPL AY X	1	1.00	922.98	124	124	0.00
*	2840003408284PT	ROD ASY	1	1.00				
*	2840003438460PT	BRACKET AY	1	1.00				
*	2840003453650PT	MNFOLD A X	1	0.95	988.08	58	58	0.00
*	2840003479492PT	GUIDE X	1	1.00	429.49	60	60	0.00
*	2840003479727PT	SEE1756154	1	1.00	546.82	71	71	0.00
*	2840003485956PT	MANIFLD AY	1	1.00	2278.34	153	154	-2278.30
*	2840003522558PT	VANE ASY	2	1.00				
*	2840003957025PT	CONE ASSY	1	1.00	1196.18	89	89	0.00
*	2840003957074PT	MANIFOLD A	1	1.00	2342.60	65	65	0.00
*	2840003957083PT	MANIFOLD	1	1.00	922.81	53	53	0.00
*	2840005167004PT	MISSING	1	0.05	3638.00	44	44	0.00
*	2840005232036PT	SHAFT X	2	1.00				
*	2840010039016PT	TUBE ASSY	1	1.00	941.40	23	23	0.00
*	2840010101301PT	DUCT SEG	1	0.20				
*	2840010101302PT	DUCT SEG	1	0.20	2818.00	5	6	-2818.00
	2840010135155PT	DUCT ASY X	1	1.00	35274.12	40	33	246918.84
	2840010171900PT	SHIELD ASY	1	1.00	477.21	51	56	-2386.05
	2840010206141PT	DUCT ASSYX	2	1.00	1814.24	39	22	30842.0
*	2840010272400PT	BLADE TURB	72	1				
*	2840010446143PT	MANIFOLD	1	1.00	647.24	126	126	0.00
*	2840010562695PT	BRACKET X	1	1.00	387.97	121	121	0.00
*	2840010636533PT	ROD AY	1	1				
*	2840010636535PT	MANIFLD AY	1	1	310.38	49	49	0
*	2840010636536PT	MANIFLD AY	1	1	347.54	41	41	0
*	2840010636537PT	MANIFLD AY	1	1	640.15	36	36	0
*	2840010636538PT	MANIFLD AY	1	1				
*	2840010636539PT	MANIFLD AY	1	1				
*	2840010650472PT	MANIFOLDAY	1	1	427.19	34	34	0
*	2840010654868PT	MANIFLD AY	1	1				
*	2840010819085PT	DUCT AY AF	1	1.00	90071.90	11	11	0.00
*	2840010873431PT	MANIFOLD	1	1.00				
*	2840010973017PT	DUCT ASYX	1	1				
*	2840011028596PT	TANK ASSY	1	0.95	5140.95	102	102	0.00
*	2840011240765PT	BLADE SET	36	1.00				
*	2840011288348PT	ARM ASBLYX	1	1.00	622.40	296	296	0.00
*	2840011288349PT	SUPPORTX	2	1.00	372.21	408	408	0.00
*	2840011288437PT	FLAMEHOLDX	1	1.00	6150.70	209	209	0.00
*	2840011291044PT	ARM ASBLYX	1	1.00	459.86	338	338	0.00
*	2840011336040PT	BLADE SET	34	1.00	1514.08	358	358	0.00

NSN	NAME	QPA	FAP	COST	SL_T	SL_E	DELTA $
* 2840011471898PT	MANIFOLD A	1	1.00				
* 2840011471899PT	MANIFOLD A	1	1.00				
* 2840011587262PT	MANIFOLD A	1	0.05				
* 2840011796906PT	REDUC GBX	1	1	7406.00	9	9	0
* 2840011796754PT	SEE2057554	1	1				
* 2840012000011PT	HOUSING	1	1				
* 2840012057554PT	SEAT	1	1				
* 3020011829302PT	GEAR	1	1				
* 3040011829427PT	GEARSHAFT	1	1				
* 2840011848741PT	CONE ASSY	1	1.00				
* 2840011925347PT	CARTRAGE	1	1.00				
* 2840012050535PT	5TH SPACER	1	1.00				
* 2840012050539PT	SUPPORT	1	1.00				
* 2840012050567PT	10-13 CASE	1	1.00				
* 2840012057555PT	6TH SPACER	1	1.00				
* 2840012057556PT	8TH SPACER	1	1.00				
* 2840012057576PT	7TH SPACER	1	1.00				
* 2840012058297PT	9TH SPACER	1	1.00				
* 2840012144276PT	TOBI	1	1.00				
* 2840012144277PT	6TH SEAL	1	1.00				
* 2840012144278PT	1TH STATOR	1	1.00				
* 2840012144407PT	11TH STATO	1	1.00				
* 2840012149691PT	5TH SEAL	1	1.00				
* 2840012149693PT	8TH AIRSEA	1	1.00				
* 2840012149694PT		1	1.00				
* 2840012149717PT	9TH SEAL	1	1.00				
* 2840012149718PT	ARM ASSY	1	1.00				
* 2840012149897PT	CASE INTER	1	1.00				
* 2840012149907PT	11TH STATO	1	1.00				
* 2840012149908PT	10TH STATO	1	1.00				
* 2840012149909PT	10TH STATO	1	1.00				
* 2840012149910PT	12TH STATO	1	1.00				
* 2840012149918PT	12TH STATO	1	1.00				
* 2840012149919PT	DIFFUSER	1	1.00				
* 2915003548690PT	SEE0427831	1	1.00				
* 2915003653631PT	VALVE ASSY	1	0.99				
* 2915003653715PT	HSG/INSERT	1	1	4202.07	24	24	0
* 2915003653717PT	COVER ASSY	1	1				
* 2915003653735PT	COVER ASSY	1	1				
* 2915003653736PT	BRG POST A	1	1				
* 2915003696053PT	SLEEVE ASY	1	1	215.31	33	33	0
* 2915003712720PT	HSG INSERT	1	1	2063.26	50	50	0
* 2915004159828PT	SHAFT INRT	1	1	93.75	37	37	0
* 2915004159874PT	SEE0963255	1	1.00				
* 2915010287492PT	FILTER X	1	1.00	1000.64	40	40	0.00
* 2915010348768PT	GEAR/BRG	1	1				
* 2915010349216PT	INTER HOUS	1	1				
* 2915010350276PT	C.E.N.C.	1	1.00	18097.46	131	131	0.00
* 2915003276237PT	SHAFT ASY	1	1.00	279.09	106	106	0.00
* 2915003276242PT	HOUSING	1	1.00	840.44	82	82	0.00
* 2915003276244PT	HOUSING	1	1.00	230.39	97	97	0.00
* 2915003276350PT	ARM ASY	1	1.00	261.12	1	1	0.00

	NSN	NAME	QPA	FAP	COST	SL_T	SL_E	DELTA $
*	2915003276367PT	HOUSING	1	1.00	118.15	48	48	0.00
*	2915010353771PT	P/D VALVE	1	1.00	1926.46	48	48	0.00
*	2915010645945PT	F16 UFC X	1	1				
*	2915010645946PT	F15 UFC X	1	1.00	169136.30	23	23	0.00
*	2915002767431PT	BODY ASSY	1	1.00				
*	2915002767445PT	LEVER ASY	1	1.00				
*	2915002767462PT	LEVER ASY	1	1.00				
*	2915002786766PT	SEE0821075	1	1.00				
*	2915002786843PT	SEE0821070	1	1.00				
*	2915002795764PT	LEVER ASY	1	1.00				
*	2915002795774PT	SEE1150300	1	1.00				
*	2915002795775PT	LEVER ASY	1	1.00				
*	2915003215042PT	HARNESS AY	1	1.00				
*	2915003454050PT	SEAT ASSY	1	1.00				
*	2915003493084PT	SHAFT ASSY	1	1.00				
*	2915003493539PT	BRACKET	1	1.00				
*	2915003523916PT	VALVE ASY	1	1.00				
*	2915003523930PT	PIST+SLV A	1	1.00				
*	2915003523932PT	LEVER ASSY	1	1.00				
*	2915003524723PT	COVER ASSY	1	1.00				
*	2915003524767PT	HOUSING AY	1	1.00				
*	2915003548692PT	BODY ASY	1	1.00				
*	2915003679304PT	LEVER ASY	1	1.00				
*	2915003829084PT	LEVER ASSY	1	1.00				
*	2915003958837PT	SEE0205442	1	1.00				
*	2915005836281PT	SHAFT ASY	1	1.00				
*	2915010032748PT	SEE1055410	1	1.00				
*	2915010032749PT	SEE1055411	1	1.00				
*	2915010032750PT	SEE1055413	1	1.00				
*	2915010041174PT	SEE1055412	1	1.00				
*	2915010063032PT	LEVER ASY	1	1.00				
*	2915010205354PT	SEE0963255	1	1.00				
*	2915010205438PT	ARACKET	1	1.00	4620.53	34	34	0.00
*	2915010205439PT	BODY ASSY	1	1.00				
*	2915010205442PT	LEVER ASSY	1	1.00				
*	2915010205443PT	LEVER ASSY	1	1.00				
*	2915010205444PT	SHAFT ASY	1	1.00				
*	2915010205445PT	LEVER ASY	1	1.00				
*	2915010205446PT	SHAFT CAM	1	1.00				
*	2915010213949PT	SEE0674449	1	1.00				
*	2915010213950PT	BRACKET	1	1.00	4670.43	11	11	0.00
*	2915010222588PT	SEE0821071	1	1.00				
*	2915010419335PT	SEE1152704	1	1.00				
*	2915010427831PT	BODY ASY	1	1.00	801.07	39	39	0.00
*	2915010427942PT	BODY ASSY	1	1.00	6952.80	35	35	0.00
*	2915010439407PT	SEE2005287	1	1.00	4022.07	14	14	0.00
*	2915010440274PT	LEVER ASSY	1	1.00				
*	2915010450933PT	SEE1055414	1	1.00				
*	2915010672009PT	SEE0963255	1	1.00				
*	2915010672010PT	BODY ASSY	1	1.00	5362.23	3	3	0.00
*	2915010674447PT	BODY ASSY	1	1.00				
*	2915010674448PT	LEVER ASSY	1	1.00				

	NSN	NAME	QPA	FAP	COST	SL_T	SL_E	DELTA $
*	2915010674449PT	HOUSING	1	1.00				
*	2915010674450PT	BODY ASSY	1	1.00				
*	2915010686465PT	SEE1055415	1	1.00				
*	2915010687577PT	SEE1150300	1	1.00				
*	2915010819645PT	BODY-PISTO	1	1.00				
*	2915010819647PT	SEE0963255	1	1.00				
*	2915010819648PT	VALVE ASSY	1	1.00				
*	2915010821070PT	BODY ASSY	1	1.00				
*	2915010821071PT	BRACKET AS	1	1.00				
*	2915010821075PT	BRACKET	1	1.00	1130.80	38	38	0.00
*	2915010830386PT	VALVE-SCRE	1	1.00	212.87	126	126	0.00
*	2915010963255PT	HARN+SCREE	1	1.00				
*	2915010967480PT	MOTOR PLA	1	1.00				
*	2915011055410PT	SOLENOID	1	1.00				
*	2915011055411PT	SOLENOID	1	1.00	325.39	85	85	0.00
*	2915011055412PT	SOLENOID	1	1.00				
*	2915011055413PT	SOLENOID T	1	1.00				
*	2915011055414PT	SOL SEG 5	1	1.00				
*	2915011055415PT	SOLENOID	1	1.00	334.84	92	92	0.00
*	2915011150299PT	SEE2005287	1	1.00				
*	2915011150300PT	BRACKET	1	1.00				
*	2915011152704PT	BODY SUBAS	1	1.00				
*	2915011418061PT	SEE2005287	1	1.00				
*	2915011455020PT	FILTER	1	1.00	412.14	119	119	0.00
*	6105010688117PT	SEE0944504	1	1.00				
*	6105010694253PT	SEE0944503	1	1.00				
*	6105010944503PT	MOTOR MN	1	1.00				
*	6105010944504PT	MOTOR AJ	1	1.00				
*	2915010659589PT	AUG FUEL P	1	1.00	27223.20	42	42	0.00
*	2915002786745PT	HOUSING	1	1.00	2042.75	14	14	0.00
*	2915010753518PT	EEC,F15 X	1	1.00				
*	2915002786710PT	HOUSING	1	1.00				
*	2915003033637PT	HOUSING	1	1.00				
*	2915003591158PT	BOARD ASY	1	1.00	4382.54	14	14	0.00
*	2915003712582PT	FRAME,F15	1	1.00				
*	2915003736372PT	FRAME ANLG	1	1.00				
*	2915003736405PT	BOARD ASY	1	1.00				
*	2915003736455PT	FRAME	1	1.00				
*	2915003736456PT	COVER	1	1.00				
*	2915004944056PT	BRD AS F15	1	1.00				
*	2915010611101PT	SEE NEW #S	1	1.00	2942.45	18	18	0.00
*	2915010611102PT	SEE1244929	1	1.00	13753.45	1	1	0.00
*	2915010972482PT	BRD ASSY	1	1.00				
*	2915011244929PT	ANALOG BRD	1	1.00	15068.80	13	13	0.00
*	6685010983986PT	THERMOCPL	1	1.00	1191.74	51	51	0.00
*	2915010819055PT	N2/SENSORX	1	1.00	5940.59	73	73	0.00
*	2915010225202PT	BODY ASSY	1	1.00				
*	2915010879610PT	EEC,F16 X	1	1	56936.86	18	17	56936.86
*	2915010928420PT	BRD AS,F16	1	1				
*	2915010930112PT	BRD ASBLY	1	1				
*	2915010930113PT	SEE1244929	1	1				
*	2915010930423PT	FRAME,F16	1	1				

NSN	NAME	QPA	FAP	COST	SL_T	SL_E	DELTA $
* 2915010996731PT	COVER ASSY	1	1	657.20	6	6	0
* 2915010996732PT	IMPELLER	1	1	531.15	53	53	0
* 2915010999184PT	PISTON/LNK	1	1				
* 2915011076177PT	TT2.5SENSX	1	1.00	14685.16	35	35	0.00
* 2915011332467PT	BACKUPCTRL	1	1	23313.47	26	25	23313.47
* 2915010668839PT	LVR&BRACKT	1	1				
* 2915010668840PT	LVR/INSRTS	1	1				
* 2915010668842PT	HOUS/INSRT	1	1				
* 2915010683902PT	LVR/INSRTS	1	1				
* 2915010824015PT	HSG&INSRTS	1	1	10040.43	5	5	0
* 2915010855049PT	SEE1332419	1	0.77				
* 2915011332419PT	BASE VALVE	1	0.23	3428.87	6	6	0
* 3040010711653PT	SHAFT/KEY	1	1				
* 3040010865270PT	SHAFT /KEY	1	1				
* 2915011376551PT	CONTROLERX	1	1.00	7576.35	62	58	30305.40
* 2915002767402PT	BELLOWSASS	1	1.00	266.22	46	40	1597.32
* 2915002795776PT	BODY ASSY	1	1.00				
* 2915003353199PT	LEVER ASSY	1	1.00	235.21	65	58	1646.47
* 2915003454020PT	LEVER ASSY	1	1.00				
* 2915010958512PT	VALVE ASSY	1	1.00	883.08	29	24	4415.40
* 2915011493883PT	CART ASSY	1	1	20818.52	66	65	20818.53
* 2915011620998PT	MFP F15 X	1	1.00	38781.14	58	58	0.00
* 2915003653631PT	VALVE ASSY	1	1.00				
* 2915003653715PT	HSG/INSERT	1	1.00	4202.07	24	24	0.00
* 2915003653717PT	COVER ASSY	1	1.00				
* 2915003653735PT	COVER ASSY	1	1.00				
* 2915003653736PT	BRG POST A	1	1.00				
* 2915003696053PT	SLEEVE ASY	1	1.00	215.31	33	33	0.00
* 2915003712720PT	HSG INSERT	1	1.00	2063.26	50	50	0.00
* 2915004159828PT	SHAFT INRT	1	1.00	93.75	37	37	0.00
* 2915010348768PT	GEAR/BRG	1	1.00				
* 2915010349216PT	INTER HOUS	1	1.00				
* 2915010996731PT	COVER ASSY	1	1.00	657.20	6	6	0.00
* 2915010996732PT	IMPELLER	1	1.00	531.15	53	53	0.00
* 2915010999184PT	PISTON/LNK	2	1.00				
* 2915011493883PT	CART ASSY	1	1.00	20818.52	66	65	20818.53
* 2915011621057PT	STRAINER	1	1.00				
* 2915011617435PT	HSG-INSERT	1	1.00				
* 2915011631758PT	STRAINER	1	1.00				
* 2915011631634PT	IMPELLER	1	1.00	1479.53	26	26	0.00
* 2915011621057PT	STRAINER	1	1				
* 2915011631634PT	IMPELLER	1	1	1479.53	26	26	0
* 2915011800246PT	EEC F15	1	1.00	44911.69	51	51	0.00
* 2915011807299PT	GEAR PUMP	1	0.91	23802.91	48	48	0
* 2915011807300PT	HSG ASSY	1	1	4598.65	10	10	0
* 2915011811217PT	HSG/CVR AS	1	1	5637.34	10	10	0
* 4810011826251PT	VALVE ASSY	1	1	193.49	61	61	0
* 4810011826252PT	VALVE ASSY	1	1	470.14	19	19	0
* 2915011819813PT	BYPASS VLV	1	0.91				
* 2915011806080PT	HOUSING	1	1				
* 2915011806081PT	SEAT/INSRT	1	1				
* 2915011806082PT	CAP	1	1				

NSN	NAME	QPA	FAP	COST	SL_T	SL_E	DELTA $
* 2925003276210PT	CABLE	1	1.00	601.94	100	100	0.00
* 2925003276212PT	ROTOR X	1	1.00	1168.42	83	83	0.00
* 2925003276213PT	SEE0228332	1	1				
* 2925003276214PT	EXCITER X	1	1.00	1929.45	36	36	0.00
* 2925011309265PT	RESISTOR	1	1.00				
* 2925003276216PT	CABLE	1	1.00	3968.51	131	131	0.00
* 2925003276226PT	CABLE	1	1				
* 2925003276227PT	CABLEX	1	1.00	540.05	72	72	0.00
* 2925003292283PT	SEE0753343	1	1.00				
* 2925003292296PT	CABLE X	1	1.00	1335.13	152	152	0.00
* 2925003292297PT	CABLE	1	1.00	716.60	73	73	0.00
* 2925003548568PT	CABLE	1	1.00	195.22	212	212	0.00
* 2925010225155PT	SEE0685284	1	1.00				
* 2925010228332PT	EXCITER	1	1.00	3309.08	66	66	0.00
* 2925010632244PT	CABLE	1	1				
* 2925010685284PT	CABLE	1	1.00				
* 2925010753343PT	INTRCONBOX	1	1.00	1696.29	193	193	0.00
* 2925010772203PT	CABLE	1	1.00	1091.07	69	69	0.00
* 2925010792129PT	CABLE	1	1.00	757.55	59	59	0.00
* 2925011802149PT	STATORGENX	1	1.00				
* 2925011811216PT	STATORHOUS	1	1.00				
* 2935003616513PT	SEE1584269	1	1.00				
* 2935011611058PT	GAS GEN	1	1.00	4235.41	19	19	0.00
* 2935010078381PT	COOLER X	4	1.00	788.00	179	180	-788.00
* 2935011584269PT	COOLER X	1	1.00	9880.74	85	85	0.00
* 2935003616516PT	SENSOR ASY	1	1.00	1339.84	3	3	0.00
* 2935011611058PT	GAS GEN	1	1.00				
* 2935011611059PT	CORE AUG	1	1.00	3556.39	13	13	0.00
* 2995002952481PT	CYL A ACTX	1	1.00				
* 2995003715928PT	BODY ASSY	1	1.00				
* 3010006108430	STARTER DR	1	1.00				
* 3010010067567	MTR	1	1.00				
* 3110011288083PT	BEARING RC	2	1.00	176.78	331	331	0.00
* 4710002832239PT	TUBE ASSY	1	1.00	273.76	152	152	0.00
* 4710002832241PT	TUBE ASY	1	1.00				
* 4710002834988PT	TUBE ASY	1	1.00	513.27	11	11	0.00
* 4710002834998PT	TUBE ASY	1	1.00	504.58	96	96	0.00
* 4710002835001PT	TUBE ASY	1	1.00	612.76	49	49	0.00
* 4710003290920PT	TUBE ASY	1	1.00	374.24	90	90	0.00
* 4710003290921PT	TUBE ASY	1	1.00	319.61	61	61	0.00
* 4710003290946PT	TUBE ASY	1	1.00				
* 4710003290961PT	TUBE ASY	1	1.00				
* 4710003290963PT	TUBE ASY	1	1.00				
* 4710003291004PT	TUBE ASY	1	1.00				
* 4710003325594PT	236.00SY	1	1.00				
* 4710003325599PT	TUBE ASY	1	1.00				
* 4710003336687PT	TUBE ASY	1	1.00	368.55	5	5	0.00
* 4710003336716PT	TUBE ASY	1	1.00	401.67	105	105	0.00
* 4710003349421PT	TUBE ASSY	1	1.00	746.07	107	107	0.00
* 4710003349464PT	TUBE ASY	1	1.00	673.61	32	32	0.00
4710003349515PT	TUBE ASY	1	1.00	439.24	105	105	0.00
4710003349519PT	TUBE ASY	1	1.00	573.26	67	67	0.00

NSN	NAME	QPA	FAP	COST	SL_T	SL_E	DELTA $
* 4710003479723PT	SEE1795109	1	1.00				
* 4710003998420PT	TUBE ASY	1	1.00	263.25	132	132	0.00
* 4710004150527PT	TUBE ASY	1	1.00	480.91	208	208	0.00
* 4710005150330PT	TUBE ASY	1	1.00	311.33	150	150	0.00
* 4710010260348PT	TUBE ASY	1	1.00	365.67	41	41	0.00
* 4710010344799PT	TUBE ASY	1	1.00				
* 4710010632199PT	TUBE ASSY	1	1				
* 4710010632200PT	TUBE AY	1	1				
* 4710010632206PT	TUBE AY	1	1				
* 4710010632870PT	TUBE AY	1	1				
* 4710011756154PT	TUBE ASY X	1	1.00	604.78	128	128	0.00
* 4710011795109PT	TUBE ASY X	1	1.00	444.68	218	218	0.00
* 4710011848915PT	TUBE ASSY	1	1				
* 4710011903005PT	TUBE ASSY	1	1				
* 4730003336684PT	TUBE ASY	1	1.00	611.54	50	50	0.00
* 4730003421580PT	TUBE ASBLY	1	1.00				
* 4730010033503PT	SEE0940209	1	1.00	819.73	10	10	0.00
* 4730010701407PT	CONNECTOR	1	1.00				
* 4730010940209PT	CONNECTOR	1	1.00				
* 4730011807319PT	MANIFOLD	1	1				
* 4730011862498PT	RING	1	1.00				
* 4810010352340PT	VALVE X	1	1.00	3237.54	41	41	0.00
* 4810010630838PT	VALVE	1	1	2662.98	31	31	0
* 4810010632236PT	VGT VALVE	1	1	3248.23	9	9	0
* 4810010667137PT	VALVE	1	1.00	1093.49	41	41	0.00
* 4820005314148PT	SEE0955359	1	1.00				
* 4820010955359PT	APR VALVE	1	1.00				
* 6680011288000PT	RECORDER	1	1.00	11847.47	122	122	0.00
* 6680010999822PT	CC ASBLY	1	1.00	1850.65	9	9	0.00
* 6680011004398PT	CC ASBLY	1	1.00	1824.74	10	10	0.00
* 6680011004399PT	CC ASBLYPS	1	1.00				
* 6680011004400PT	CC ASBLY	1	1.00	1573.35	8	8	0.00
* 6680011878346PT		1	1.00				
* 6680011890333PT		1	1.00				
* 6685010492962	INDICATOR	1	1.00				
* 6685010610362PT	PROBE	1	1.00	992.48	100	100	0.00
* 6695003829046	HT DISSIPA	1	1.00				
* 6695010185874	COVER	1	1.00				
* 6695010320401	CIRCUIT BD	1	1.00				
* 6695010330219	CIRCUIT BD	1	1.00				
* 6695010344093	CIRCUIT BD	1	1.00				
* 6695010344094	CIRCUIT BD	1	1.00				
* 6695010357224	CIRCUIT BD	1	1.00				
* 8145010363152PT	COVER	1	1.00				
* 8145011335561PT	COVER	1	1.00				
* 8145011339838PT	COVER	1	1.00				
* 8145011461453PT	COVER ASSY	1	1.00				
F0100-23A/24A	FAN MODULE	1	1.00				
2840003214600PT	HLDR SLRNG	1	1.00	1322.50	70	59	14547.50
2840003326677PT	SEAT	1	1.00				
2840003407556PT	BRACKET	1	1.00	270.57	162	141	5681.97
2840003479491PT	VANE	17	1.00	475.17	920	783	65098.29

NSN	NAME	QPA	FAP	COST	SL_T	SL_E	DELTA $
2840003479575PT	VANE	4	1.00	629.66	486	409	48483.82
2840003479580PT	SHROUD	1	1.00	2315.95	70	44	60214.70
2840003486245PT	VANE	52	1.00	131.23	980	909	9317.33
2840003522148PT	SEAL ASY	1	1.00	936.00	84	74	9360.00
2840003651958PT	SEE1850792	1	1.00				
2840003651964PT	BLADE SET	30	1.00	1097.12	83	73	10971.20
2840003651966PT	BLADE SET	20	1.00	685.46	48	36	8225.52
2840003652114PT	RETAINER	1	1.00	1716.71	77	62	25750.65
2840003944936PT	BLADE SET	19	1.00				
2840003957077PT	MANIFLD AY	1	1.00	890.62	104	83	18703.02
2840005186273PT	SUPPORT	1	1.00				
2840005186276PT	SUPPORT	1	1.00	487.42	139	131	3899.36
2840005186281PT	CASE ASSY	1	1.00	4686.50	49	25	112476.00
2840005355121PT	HOUSNG AYX	1	1.00	6920.85	80	47	228388.05
2840005957068PT	CASE&STATR	1	1.00	36654.30	55	29	953011.80
2840005957069PT	CASE / STA	1	1.00	28387.69	51	20	880018.39
2840010271338PT	RING ASSY	1	1.00				
2840010272398PT	BLADE INDX	60	1.00	310.89	1460	1278	56581.98
2840010272399PT	BLADE INDX	40	1.00	317.78	1045	914	41629.18
2840010288004PT	BLADE INDX	38	1.00				
2840010559371PT	RING	1	1.00				
2840010816328PT	SEE1850791	1	1.00				
2840011349233PT	CASE ASSY	1	1.00	32198.92	68	36	1030365.44
2840011360550PT	DISK ASSY	1	1.00	10924.73	11	0	120172.03
2840011360558PT	DISK/HUB	1	1.00	8676.72	68	49	164857.68
2840011360559PT	DISK/HUB	1	1.00	10954.35	99	69	328630.49
2840011848573PT	AIR SEAL	1	1.00	2115.45	76	60	33847.20
2840011848574PT	AIR SEAL	1	1.00				
2840011848575PT	AIR SEAL	1	1.00	2386.09	72	57	35791.35
2840011848739PT	SHROUD	1	1.00				
2840011848740PT	CASE&STATR	1	1.00				
2840011850791PT	SEAL RING	1	1.00	1780.52	54	44	17805.20
2840011850792PT	SEAL RING	1	1.00				
2840011922333PT	AIR SEAL	1	1.00	3256.29	150	118	104201.28
2840011922386PT	CASE&STATR	1	1.00				
2995005343027PT	CYLINDER	1	1.00				
2995003679578PT	COVER ASSY	1	1.00				
2995010995028PT	CIVV X	1	1.00	8546.12	43	27	136737.92
2995003654449PT	BODY ASSY	1	1.00				
2995003679578PT	COVER ASSY	1	1.00	185.68	93	93	0.00
6105011025829PT	STEPR MTR	1	1.00				
3110004169422PT	#1 BEARING	1	1.00	1263.75	147	124	29066.25
8145003946563PT	CONTAINER	1	1.00				
8145003946564PT	CONTAINER	1	1.00				
8145003946566PT	CONTAINER	1	1.00				
8145011169588PT	CONTAINER	1	1.00				
8145011459558PT	BASE SHELL	1	1.00				
8145011459559PT	COVER ASSY	1	1.00				
F0100-23B/24B	CORE MODULE	1	1.00				
2840002799996PT	COMPR STAT	1	1.00				
2840002800021PT	DISK ASY	1	1.00	14809.34	69	54	222140.10
2840002800022PT	DISK ASSY	1	1.00	11946.75	74	59	179201.25

NSN	NAME	QPA	FAP	COST	SL_T	SL_E	DELTA $
2840002803962PT	COUPLING	1	1.00	2334.37	121	91	70031.10
2840002803976PT	HOUSING AY	1	1.00	9650.19	4	0	38600.76
2840003265955PT	DISK/HUB	1	1.00	14820.19	75	59	237123.05
2840003266043PT	SUPPORT AY	1	1.00	5781.92	75	63	69383.04
2840003266415PT	DISK	1	1.00	10428.57	81	66	156428.55
2840003315478PT	RING ASSY	1	1.00	1353.43	75	68	9474.01
2840003315495PT	SCOOP ASSY	1	1.00				
2840003315525PT	HOLDR AY X	1	1.00				
2840003315572PT	SEAT	1	1.00	232.78	100	110	-2327.80
2840003315573PT	SEAT	1	1.00	192.52	110	122	-2310.24
2840003325758PT	DISK	1	1.00	7266.75	59	48	79934.25
2840003326683PT	SEAT ASY	1	1.00	325.37	112	116	-1301.48
2840003326767PT	SEAT ASSY	1	1.00	447.66	71	76	-2238.30
2840003326768PT	SEAT ASSY	1	1.00	207.83	56	65	-1870.47
2840003336894PT	SEAL	1	1.00	210.51	312	315	-631.53
2840003374269PT	CARRIAGE	1	1.00	450.88	83	86	-1352.64
2840003374271PT	BUMPER	1	1.00				
2840003407429PT	FAIRING	1	1.00	1708.77	210	188	37592.94
2840003437601PT	SEAL ASSY	1	1.00	527.96	68	65	1583.88
2840003437633PT	SUPPORT AY	1	1.00	1460.14	120	108	17521.68
2840003437644PT	HOUSING	1	1.00				
2840003437692PT	SEAL ASSY	2	1.00	640.13	148	127	13442.73
2840003437899PT	HOUSING	1	1.00	2541.45	92	80	30497.40
2840003437900PT	RING ASBLY	1	1.00	2749.98	88	76	32999.76
2840003437939PT	SEAL	1	1.00	1453.35	116	103	18893.55
2840003437946PT	RING ASSY	1	1.00	2992.38	64	55	26931.42
2840003438131PT	RING ASY	1	1.00				
2840003438171PT	SUPPORT	1	1.00				
2840003438259PT	SCOOP X	1	1.00	806.21	58	59	-806.21
2840003438336PT	SEAT ASY	1	1.00	358.84	79	85	-2153.04
2840003438344PT	RING ASSY	1	1.00	6353.45	82	69	82594.85
2840003439227PT	SEAL ASSY	1	1.00	2643.21	119	103	42291.36
2840003453433PT	SUPPORT AY	1	1.00	8510.96	16	10	51065.76
2840003453602PT	SUPPORT AY	1	1.00				
2840003453655PT	SHROUD ASY	1	1.00	2665.88	46	38	21327.04
2840003453657PT	SHROUD AY	1	1.00	3008.08	66	56	30080.80
2840003479420PT	SHROUD	1	1.00	1029.02	61	59	2058.04
2840003479430PT	SHROUD	1	1.00	1419.20	117	103	19868.80
2840003522156PT	RING ASSY	1	1.00				
2840003522228PT	SEAL ASSY	1	1.00	2096.09	182	160	46113.98
2840003522230PT	DISK	1	1.00	9967.82	50	40	99678.20
2840003522233PT	DISK	1	1.00	3238.57	53	45	25908.56
2840003522278PT	SHROUD	1	1.00	2282.17	57	49	18257.36
2840003695360PT	DISK	1	1.00	14436.17	66	52	202106.38
2840003695362PT	PACER	1	1.00	6880.55	115	96	130730.45
2840003695558PT	SUPRT AY X	1	1.00	5638.08	76	64	67656.96
2840003712174PT	SHAFT ASSY	1	1.00	15054.92	86	68	270988.56
2840003773307PT	SEAL ASSY	1	1.00	1734.25	143	126	29482.25
2840003773310PT	SEAL ASSY	1	1.00	2016.00	159	140	38304.00
2840003773311PT	SEAL ASSY	1	1.00	2375.25	149	130	45129.75
2840003773312PT	SEAL ASSY	1	1.00				
2840003901141PT	SEAL ASY	1	1.00	3943.44	85	72	51264.72

NSN	NAME	QPA	FAP	COST	SL_T	SL_E	DELTA $
2840003901142PT	DISK	1	1.00	9996.73	96	78	179941.14
2840003901144PT	DISK ASY	1	1.00	13276.73	93	74	252257.88
2840003901162PT	SEAL ASY	2	1.00	991.08	71	66	4955.40
2840003901355PT	SHROUD AY	1	1.00	2167.85	92	81	23846.35
2840003901357PT	CASE ASSY	1	1.00	4371.76	107	92	65576.40
2840003901358PT	CASE ASY	1	1.00	5237.82	106	90	83805.12
2840003921053PT	SHROUD AY	1	1.00	2336.32	17	10	16354.24
2840003957118PT	SEAL ASSY	1	1.00	2244.18	150	131	42639.42
2840003957119PT	SUPPORT X	1	1.00				
2840003957201PT	SEAL ASSY	1	1.00				
2840004670627PT	VANE	64	1.00	115.79	1148	1138	1157.90
2840004670634PT	VANE	62	1.00	100.56	1095	1099	-402.24
2840005700752PT	SEAL ASSY	1	1.00	1221.38	31	30	1221.38
2840005700773PT	SEAL AIR	1	1.00				
2840005835484PT	SEAL RING	1	1.00	2038.75	143	111	65240.00
2840010131599PT	SEAL ASSY	1	1.00	3125.56	126	110	50008.96
2840010171899PT	CASE ASSY	1	1.00	8646.44	86	71	129696.60
2840010264628PT	CASE ASSY	1	1.00	75411.15	18	8	754111.50
2840010412255PT	RING ASY	1	1.00	4249.14	61	35	110477.64
2840010806549PT	SUPPORT X	1	1.00	5080.21	37	31	30481.26
2840010807580PT	VANE	90	1.00				
2840010808265PT	SHROUD	1	1.00				
2840010901798PT	RING ASSY	1	1.00	3782.24	104	89	56733.60
2840010938736PT	TUBE ASBLY	1	1.00	964.20	138	128	9642.00
2840010959493PT	FAIRINGF16	1	1				
2840010983956PT	FAIRINGF16	1	1				
2840011062550PT	SUPORT ASY	1	1.00	22318.45	18	17	22318.45
2840003275793PT	RING ASY	1	1.00				
2840003438475PT	RING ASBLY	1	1.00	2187.08	61	54	15309.56
2840011062551PT	SUPPORT AY	1	1.00	8364.11	57	45	100369.32
2840011123783PT	CASE ASSY	1	1.00	11295.03	53	43	112950.30
2840011144609PT	COMP STAT	1	1.00	2318.40	60	52	18547.20
2840011240763PT	CASE F16	1	1	78880.14	6	0	473280.8
2840011253853PT	VANE 1T	1	1.00	1268.97	263	238	31724.25
2840011253854PT	VANE 1T	22	0.20	1225.58	525	461	78437.12
2840011253855PT	VANE 1T	22	1.00	1225.58	1242	1104	169130.03
2840011253856PT	VANE 1T	22	0.07	1224.50	377	328	60000.50
2840011302407PT	CASE ASSY	1	1.00	56914.11	44	26	1024453.98
2840011231001PT	TUBE AS X	1	1.00				
2840011320121PT	CHAMBER AY	1	1.00				
2840011768600PT	STATOR ASY	1	1.00	10831.05	14	6	86648.40
2840011768601PT	STATOR ASY	1	1.00	8933.90	49	40	80405.10
2840011768602PT	STATOR ASY	1	1.00				
2840011768603PT	STATOR ASY	1	1.00				
2840011768604PT	STATOR ASY	1	1.00				
2840011768605PT	STATOR ASY	1	1.00				
2840011769155PT	STATOR ASY	1	1.00				
2840011892575PT	ARM ASSY X	2	1.00	198.08	115	127	-2376.96
2840011892826PT	ARM ASSY X	2	1.00	624.68	78	59	11868.92
2840011920886PT	COMP STAT	1	1.00				
2840011927404PT		1	1.00				
2840012149690PT	7TH SEAL	1	1.00				

NSN	NAME	QPA	FAP	COST	SL_T	SL_E	DELTA $
2840012149692PT	4TH SEAL	1	1.00				
2840012149719PT	13TH DISK	1	1.00				
2840012149899PT	12TH DISK	1	1.00				
2840012149900PT	10TH DISK	1	1.00				
2840012149901PT	9TH DISK	1	1.00				
2840012149903PT	5TH DISK	1	1.00				
2840012149904PT	13TH DISK	1	1.00				
2840012149905PT	11TH DISK	1	1.00				
2915003454025PT	MANIFOLD	1	1.00	740.46	208	191	12587.82
2915003454029PT	MANIFLD RH	1	1.00	678.28	206	192	9495.92
2915011059502PT	NOZZLE	16	1.00	487.76	325	288	18047.12
3010011421068PT	COUPLING	2	1.00	197.39	363	368	-986.95
3110003456018PT	BEARING =3	1	1.00	2937.00	172	152	58740.00
3110003456121PT	BEARING #2	1	1.00	2624.08	83	57	68226.08
3110004169421PT	BEARING =4	1	1.00				
3110011372472PT	BEARING #4	1	1.00				
4710010770705PT	TUBE AS X	1	1.00				
5310010339081PT	NUT	1	1.00	1898.03	117	106	20878.33
6685002842236PT	PROBE	1	1.00	833.78	48	28	16675.60
8145003962056PT	CONTAINER	1	1.00				
8145011169587PT	CONTAINER	1	1.00				
8145011459563PT	COVER ASSY	1	1.00				
8145011459564PT	BASE SHELL	1	1.00				
8145011898101PT		1	1.00				
8145011925525PT		1	1.00				
8145011925526PT		1	1.00				
F0100-23C/24C	FDT MODULE	1	1.00				
2840002799992PT	HUB ASY	1	1.00	4063.68	70	50	81273.60
2840003214577PT	DUCT	1	1.00	1102.98	84	69	16544.70
2840003266018PT	SUPPORT X	1	1.00	823.53	150	114	29647.08
2840003275429PT	SEAL	1	1.00	878.23	101	84	14929.91
2840003351959PT	RING SEGM	4	0.15				
2840003374698PT	STIFFENER	1	1.00				
2840003374703PT	STIFFENER	1	1.00				
2840003374704PT	PLUG	1	1.00	750.55	80	70	7505.50
2840003407343PT	SEAL ASY	1	1.00	1036.65	81	66	15549.75
2840003437440PT	SEAT	1	1.00	195.93	30	28	391.86
2840003437805PT	SUPPORT X	1	1.00	5525.97	66	45	116045.37
2840003485990PT	SUPPORT	1	1.00	2047.11	77	58	38895.09
2840003934231PT	RING ASY X	1	1.00	2445.67	92	69	56250.41
2840003944941PT	BLADE SET	30	1.00				
2840003956915PT	RING ASY	1	1.00	1776.24	185	147	67497.12
2840003957060PT	DISK	1	1.00				
2840004359596PT	010645015	1	1.00				
2840004359601PT	SUPPORT X	1	1.00	1946.64	37	29	15573.12
2840005263432PT	VANE 4T	29	0.69	373.75	741	611	48587.50
2840005301569PT	VANE 4T	29	0.22	384.03	235	211	9216.72
2840005301594PT	VANE 4T	29	0.07	392.56	127	118	3533.04
2840005700716PT	BLADE SET	34	1.00				
2840005700810PT	VANE AY 3T	7	0.61	503.09	301	260	20626.69
2840005700824PT	VANE AY 3T	23	0.15	540.42	261	223	20535.96
2840005700873PT	VANE AY 3T	7	0.16	603.78	196	167	17509.62

NSN	NAME	QPA	FAP	COST	SL_T	SL_E	DELTA $
2840005741679PT	VANE AY 3T	23	0.16	513.93	352	283	35461.17
2840005741685PT	VANE AY 3T	23	0.61	540.42	509	410	53501.58
2840010074281PT	VANE ASY	1	1.00	706.95	150	127	16259.85
2840010074282PT	VANE ASY	7	0.19	514.52	90	83	3601.64
2840010079113PT	MISSING	23	0.05				
2840010126471PT	DISK ASY	1	1.00	12789.37	55	32	294155.51
2840010130481PT	SEAL	1	1.00	2460.93	204	155	120585.57
2840010272401PT	BLADE TURB	60	1.00	199.56	902	799	20554.68
2840010272404PT	BLADE TURB	68	1.00	179.32	1430	1260	30484.40
2840010289683PT	RING	1	1.00	1075.96	116	95	22595.16
2840010290251PT	SHAFT ASSY	1	1.00	13407.06	56	33	308362.39
2840010645014PT	CASE+DUCT	1	1.00	24317.62	75	35	972704.81
2840010645015PT	CASE ASSY	1	1.00	15271.86	29	26	45815.58
2840011670940PT	SUPPORT	1	1.00	2221.40	163	164	-2221.40
2840011671002PT	DUCT SGMT	18	1.00	199.08	285	277	1592.64
2840011160937PT	SEAL	1	1.00	7276.51	178	121	414761.07
2840011358850PT	CASE ASSY	1	1.00	28702.77	29	12	487947.09
2840011738628PT	RING SEGM	4	1.00	817.84	404	334	57248.80
2840011771742PT	RING SEGMT	1	1.00	1060.77	209	173	38187.72
2840011798314PT	RING SEGMT	8	1.00				
2840011906863PT	RING ASY	1	1.00	989.19	281	215	65286.54
2840011951084PT	RING SEGMT	9	1.00				
2840011967209PT		1	1.00				
3110005091975PT	BEARING #5	1	1.00	2060.23	168	121	96830.81
8145003946561PT	CONTAINER	1	1.00				
8145003946697PT	CONTAINER	1	1.00				
8145003946698PT	CONTAINER	1	1.00				
8145011169590PT	CONTAINER	1	1.00				
8145011459562PT	BASE SHELL	1	1.00				
F0100-23F/24F	AUG MODULE	1	1.00				
2840003479686PT	SEAL ASY X	15	1.00				
2840003486232PT	NOZL SEGMX	15	1.00	890.83	332	258	65921.42
2840005167788PT	RING ASY	1	1.00				
2840005341824PT	SEAL ASY X	15	1.00				
2840010039017PT	SUPPORT X	1	1.00	17971.65	94	55	700894.35
2840010039018PT	DUCT ASY X	1	1.00				
2840010112877PT	NOZZLE SEG	15	1				
2840010491150PT	LINER ASSX	1	1.00	28639.12	89	21	1947460.17
2840010865208PT	NOZLE SEGX	15	1	2369.66	329	254	177724.5
2840011433254PT	SEAL ASSY	15	1.00	466.37	1800	1448	164162.24
2840011559148PT	DIV NOZLEX	15	1.00	1473.11	970	718	371223.72
2840011649087PT	NOZZLE SEG	15	1.00				
2840011802935PT	LINER ASSY	15	1.00	236.94	1302	1066	55917.84
2840011802941PT	LINER AY	15	1.00	569.40	657	509	84271.20
2915010715952PT	PRIMEACT X	1	1.00	7092.41	82	49	234049.53
2915002884686PT	GEARSHAFT	1	1.00				
2915010838477PT	TUBE ASSY	1	1.00				
2915010718325PT	2ND ACT X	4	1.00	5215.26	78	20	302485.08
2915010838477PT	TUBE ASSY	1	1.00				
8145003946562PT	CONTAINER	1	1.00				
8145011169589PT	CONTAINER	1	1.00				
8145011459560PT	BASE SHELL	1	1.00				

NSN	NAME	QPA	FAP	COST	SL_T	SL_E	DELTA $
8145011459561PT	COVER ASSY	1	1.00				
F0100-23G/24G	GEAR MODULE	1	1.00				
2840003214567PT	COUPLING	1	1.00	865.30	167	102	56244.50
2840003291270PT	SLEEVE	1	1.00				
2840003291294PT	IMPELLER	1	1.00	544.46	92	70	11978.12
2840003479697PT	SHAFT	1	1.00	1188.05	87	56	36829.55
2840010213934PT	SEAT	1	1.00	452.44	6	2	1809.76
2840010214178PT	COVER ASY	1	1.00	602.67	43	34	5424.03
2840010214180PT	HOUSING AY	1	1.00	6516.47	67	28	254142.33
2840011420863PT	GEARBOX AY	1	1.00				
2840011452282PT	HOUSING AY	1	1.00				
2840011920875PT	HSNG ASSY	1	1.00				
2945011441402PT	FILTER	1	1.00	1831.24	115	73	76912.08
3020003205179PT	GEAR	1	1.00	358.07	1	0	358.07
4320010143593PT	PMP MN OLX	1	1.00	9803.73	32	13	186270.87
2840003326745PT	HOUSING	1	1.00				
2840003326752PT	HOUSING	1	1.00	499.11	26	23	1497.33
2840003374255PT	HOUSING AY	1	1.00				
2840003437826PT	HOUSING	1	1.00				
4320003562578PT	HOUSING	1	1.00	346.59	104	94	3465.90
4320010150479PT	PUMP ASSY	1	1.00	1868.83	77	48	54196.07
4320011878144PT	PUMP	1	1.00	10609.89	42	13	307686.81
2840003374255PT	HOUSING AY	1	1.00	513.85	40	35	2569.25
2840003437826PT	HOUSING	1	1.00	2950.03	33	24	26550.27
4710010294417PT	TUBE ASY	1	1.00	460.94	152	103	22586.06
4820011526285PT	VALVE	1	1.00	968.53	82	45	35835.61
4820011526286PT	HOUSING	1	1.00	230.58	80	68	2766.96
4820011751901	VALVE	1	1.00				
4820011795573	MISSING	1	0.05				
8145003946673PT	CONTAINER	1	1.00				
8145011169586PT	CONTAINER	1	1.00				
8145011459565PT	BASE SHELL	1	1.00				
8145011459566PT	COVER ASSY	1	1.00				
F0100-23H/24H	HPT MODULE	1	1.00				
2840003214570PT	RING ASY	1	1.00	2172.10	122	75	102088.70
2840003266456PT	PLATE	1	1.00				
2840003275760PT	SEAL	1	1.00				
2840010272400PT	BLADE TURB	72	1.00				
2840011201949PT	VANE 2T	29	1.00	1023.10	897	693	208712.40
2840011201952PT	VANE 2T	29	0.18	1073.64	459	345	122394.96
2840011201953PT	VANE 2T	29	0.21	1024.85	484	382	104534.70
2840011240706PT	PLATE AY X	1	1.00	16518.11	17	7	165181.10
2840011253840PT	BLADE TURB	72	1.00	350.32	1902	1560	119809.44
2840011326738PT	DISK ASSY	1	1.00				
2840011326739PT	DISK ASSY	1	1.00				
2840011336017PT	TURB BLADE	68	1.00	705.59	2208	1758	317515.50
2840011584262PT	CASE DUCT	1	1.00	19299.19	64	31	636873.27
2840011230999PT	SUPPORT	1	1.00	2829.54	107	72	99033.90
2840011360472PT	DUCT SEG	18	1.00	125.18	983	847	17024.48
8145010351387PT	CONTAINER	1	1.00				

END
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